1127-9

TRANSACTIONS AND PROCEEDINGS

OF THE

BOTANICAL SOCIETY OF EDINBURGH

VOLUME XXXVII.

PART I.

SESSION 1954–55.

EDINBURGH:
PRINTED FOR THE BOTANICAL SOCIETY BY
NEILL & CO., LIMITED

And to be obtained from the SECRETARY OF THE SOCIETY, *at the Royal Botanic Garden*

1956

Price to Non-Members—15/-

Back numbers of the *Transactions* are available from 1928 to 1955, *i.e.* Vols. 30-36 inclusive. Additionally, a few complete volumes and several odd parts issued before 1928 are still available. Complete volumes (price £3) or separate parts (15s. each) may be purchased from the Assistant Secretary, Botanical Society of Edinburgh, Royal Botanic Garden, to whom any inquiries should be addressed

PROCEEDINGS

OF THE

BOTANICAL SOCIETY OF EDINBURGH

SESSION CXIX

OCTOBER 21, 1954.

Dr. W. BURNS, President, in the Chair.

The following Office-Bearers were elected for Session 1954–55:

PRESIDENT.

W. BURNS, C.I.E. D.Sc., F.R.S.E.

VICE-PRESIDENTS.

Mrs. J. KNOX, D.Sc.
Miss A. M. MACLEOD, Ph.D.
P. H. DAVIS, Ph.D.
B. L. BURTT, B.Sc., F.L.S., F.R.S.E.

COUNCILLORS.

G. J. FLEMING.
J. G. ROGER, B.Sc.
W. HANDYSIDE.
J. W. GREGOR, Ph.D., F.L.S.
D. H. N. SPENCE, B.Sc.
E. E. KEMP, N.D.H., D.Inst.P.A.
R. M. ADAM, F.L.S.
Miss E. BEATTIE.
J. A. MACDONALD, Ph.D., D.Sc., F.R.S.E.
Miss C. W. MUIRHEAD.

Honorary Secretary—P. S. GREEN, B.Sc., F.L.S.
Assistant Secretary—Miss D. E. PURVES.
Cryptogamic Secretary—D. M. HENDERSON, B.Sc.
Editor—Miss A. M. MACLEOD, Ph.D., Heriot-Watt College, Edinburgh.
Treasurer—R. T. HUNTER. C.A.
Artist—R. EUDALL.
Auditor—C. A. SCOTT, C.A.

The TREASURER, Mr. R. T. HUNTER, submitted the following Statement of Accounts for the Session 1953–1954:

INCOME.

Annual Subscriptions for 1953–1954	£98	5	0
Arrears of Subscriptions recovered	14	0	0
Transactions sold	23	18	0
Interest on Investments	22	11	9
Subscriptions to Publications Fund	4	10	0
Income from Botanical Society Trust Fund	12	2	0
Income Tax recovered 1953–1954	17	0	8
Grant from Carnegie Trust	100	0	0
Balance of Excursion Fund	—		
	£292	7	5
Excess of Expenditure over Income	41	13	7
	£334	1	0

EXPENDITURE.

Printing *Transactions*, **36**, part III	£221	5	6
Printing and Postages of Notices of Meetings	74	0	6
Stationery, Postages, etc.	12	13	4
Fire Insurance on Books	0	5	0
Projector and Film	8	2	0
Royal Horticultural Society Address	5	10	6
National Trust Film Expenses	1	1	0
Bank Charges	0	18	2
Honorarium to Treasurer	5	5	0
Honorarium to Assistant Secretary	5	0	0
	£334	1	0

BALANCE SHEET AS AT 31ST AUGUST 1954.

LIABILITIES.

I. Capital Funds—			
Balance brought forward from 1952–1953		£972 17	7
Add—Life Compositions received in 1953–1954	£46 2 8		
Donations	3 0 0		
		49 2	8
		£1022 0	3
Less—Excess of Expenditure over Income 1953–1954		41 13	7
		£980 6	8
II. Subscriptions received in advance—			
1954–1955	£10 5 0		
1955–1956	£1 0 0		
		11 5	0
		£991 11	8

ASSETS.

I. British Government Securities—			
(*a*) £200 3½% War Stock at cost		£194 18	3
(*b*) £258, 2s. 6d. British Transport 3% Guaranteed Stock 1978–1988 at cost		216 18	6
(*c*) £100 3% Defence Bonds at cost		100 0	0
(*d*) £100 3½% Defence Bonds at cost		100 0	0
(*e*) £250 3% Savings Bonds 1965–1975 at cost		253 18	3
		£865 15	0
II. Bank Balances—			
(*a*) Sum on Current Account with the Clydesdale and North of Scotland Bank Ltd.	£19 2 5		
(*b*) Savings Account—Union Bank of Scotland Ltd.	4 8 7		
(*c*) Edinburgh Savings Bank Account No. 5129	2 5 8		
		25 16	8
III. Grant due from Carnegie Trust		100 0	0
		£991 11	8

EDINBURGH, *2nd October* 1954.—I hereby certify that I have audited the Accounts of the Treasurer of the Botanical Society of Edinburgh for the Session 1953–1954, and have found them correct. I have also checked the foregoing Abstract and found it correct. I have seen the securities for the invested funds and found them in order.

CHARLES A. SCOTT, C.A., *Auditor.*

SIR WILLIAM WRIGHT SMITH LECTURESHIP FUND.

Session 1953–1954.

Balance of Fund brought forward from 1952–1953 . .			£280 19 0
Donations received	£17 14 0		
Interest on £250 3½% War Loan . .	8 15 0		
		26 9 0	
		£307 8 0	
Less—Expenses		4 2 6	
		£303 5 6	
Being:—£250 3½% War Loan at cost .	£203 12 0		
Edinburgh Savings Bank Account No. 312 . . .	96 11 6		
Clydesdale and North of Scotland Bank Ltd., on Current Account	3 2 0		
		£303 5 6	

EDINBURGH, *2nd October* 1954.—I hereby certify that I have audited the Accounts of the Sir William Wright Smith Lectureship Fund for the Session 1953–1954, and have found them correct. I have seen the securities for the invested funds and found them in order.

CHARLES A. SCOTT, C.A., *Auditor.*

The PRESIDENT read the following proposed amendments to the Constitution of the Society (see *Trans. Bot. Soc. Edin.* (1946), **34,** 371):

(1) Chapter III, delete paragraphs 1, 2 and 3 and substitute:

1. The general direction of the affairs of the Society shall be in the hands of a Council, consisting of a President, four Vice-Presidents, ten Councillors, a Secretary, an Assistant Secretary, a Cryptogamic Secretary, an Editor of *Transactions* and a Treasurer. Five shall be a quorum.

2. The Council shall be elected from amongst the Ordinary Fellows at the Annual General Meeting in June. They may be re-elected, except the two senior Vice-Presidents and the three senior Councillors who shall not be eligible for re-election to the same office till after an interval of one year.

3. The Secretary shall make notification in the Billet of the April Meeting of vacancies in the Council falling to be filled and shall invite nominations to fill these vacancies. Nominations may be made by any Fellow and together with the names of the proposer and seconder, shall be sent to the Secretary so as to reach him not later than the day before the Ordinary Meeting in May. To these nominations shall be added any made by the Council and the combined list shall be printed along with the Billet for the Annual General Meeting and shall be voted upon at that Meeting. Every Fellow present at the Meeting shall be entitled to vote.

(2) Chapter III, paragraph 4, delete "and an Artist".

(3) Chapter III, paragraph 6, delete "The Honorary Secretary, with the aid of the other Secretaries", and substitute "The Secretary, with the aid of the Assistant Secretary and the Cryptogamic Secretary".

(4) Chapter IV, delete paragraph 1 and substitute:

1. An Ordinary Meeting of the Society shall be held every month from October to May; normally on the second or third Thursday of each month.

(5) Chapter IV, add a new paragraph 2.

2. An Annual General Meeting shall be held each year in June at which the following business shall be transacted:

(*a*) Presentation by the Council of a Report on the work of the Society during the past year.
(*b*) Presentation of a financial statement by the Treasurer.
(*c*) Election of the Office-Bearers for the ensuing year.
(*d*) Any other business.

(6) Chapter IV, renumber present paragraphs 2 to 5 as 3 to 6 respectively.

(7) Chapter IV, delete the last paragraph and substitute:

7. The Council shall hold a Meeting for business either before or after each Ordinary Meeting of the Society unless the President shall otherwise determine. The Council may at any time be called upon by the President or any two of the Vice-Presidents or Secretaries, to meet for the transaction of business.

(8) Chapter V, paragraph 1, delete "Honorary Secretary" and substitute "Editor of *Transactions*".

The amendments were adopted unanimously.

Dr. BURNS then delivered his Presidential Address. His subject was "Some Aspects of Root Study". (See p. 1.)

NOVEMBER 18, 1954.

Dr. W. BURNS, President, in the Chair.

Miss H. M. CONNOR, Mr. A. J. C. GRIERSON and Mr. I. C. HEDGE were elected Ordinary Fellows, and Mrs. L. M. CONNOR was elected an Ordinary Member.

The following papers were read by title:

1. "Vitamin Content of Arctic Plants. Part III", by K. RODAHL. (See **36,** 267.)
2. "Features on Plant Cuticles", by D. J. MARTIN. (See **36,** 278.)
3. "Polen Grain Size in *Nasturtium* and *Cakile*", by P. S. GREEN. (See **36,** 289.)
4. "Sub-Littoral Survey of the Laminariaceae of Little Loch Broom", by F. T. WALKER. (See **36,** 305.)

Mr. J. D. MATTHEWS, Geneticist, Forestry Commission, read a paper entitled "The Improvement of Scots Pine in Scotland by Selection and Breeding".

This meeting was held in conjunction with the Lothians and Border Branch of the Royal Scottish Forestry Society.

DECEMBER 16, 1954.

Dr. W. BURNS, President, in the Chair.

Mr. J. M. DUNNETT was elected an Ordinary Fellow, and Miss J. BUCHANAN an Ordinary Member.

The following papers were read by title:

1. "Notes on Some Uncommon Algae from Lochs in Kinross, Perthshire and Caithness", by A. J. BROOK. (See **36,** 309.)
2. "A New Species of *Seguenzea*", by A. B. GUPTA. (See **36,** 317.)

Professor P. W. RICHARDS, University College of North Wales, Bangor, read a paper entitled "The Ecology of Bryophytes".

JANUARY 20, 1955.

Dr. W. BURNS, President, in the Chair.

Dr. W. J. EGGELING was elected an Ordinary Member.

Dr. R. MACLAGAN GORRIE exhibited a film of the vegetation of Bihar and Ceylon.

FEBRUARY 17, 1955.

Dr. W. BURNS, President, in the Chair.

Dr. L. W. POEL, University of St. Andrews, read a paper entitled "Uses of Radio-active Isotopes in Botanical Research".

MARCH 11, 1955.

Mr. B. L. BURTT, Vice-President, in the Chair.

At a Special Meeting, to which all Scottish botanists were invited, Dr. S. M. WALTERS gave an account of the Distribution Maps Scheme of the Botanical Society of the British Isles.

MARCH 17, 1955.

Mrs. E. M. KNOX, Vice-President, in the Chair.

The meeting took the form of a Symposium on Recent Work on the Scottish Flora.

The following papers were read:

1. "Problems in *Atriplex*", by Miss B. POULTER.
2. "Hybridization between the Woodrushes, *Luzula campestris* and *L. multiflora*", by Miss J. BUCHANAN.
3. "A Comparative Study of *Empetrum nigrum* and *E. hermaphroditum*", by J. R. MACKAY.

APRIL 21, 1955.

Dr. W. BURNS, President, in the Chair.

Dr. J. MILNE, Mr. H. BRITTEN, Mr. G. G. LANFRANCO and Dr. J. K. MORTON were elected Ordinary Fellows.

Dr. P. H. DAVIS read a paper entitled "An Expedition to Turkish Kurdistan".

MAY 16, 1955.

Dr. W. BURNS, President, in the Chair.

Miss E. ELLIOT was elected an Ordinary Member.

Dr. W. BLYTH read a paper entitled "Reflections on Fungi of Medical Importance".

JUNE 16, 1955.

ANNUAL GENERAL MEETING.

Dr. W. BURNS, President, in the Chair.

The PRESIDENT announced that a Committee for the Study of the Scottish Flora had been constituted, acting under the joint aegis of the Botanical Society of Edinburgh and the Botanical Society of the British Isles. The Committee had appointed Mr. B. L. BURTT as its Chairman and Mr. B. W. RIBBONS as its Secretary.

The following Office-Bearers were elected for the Session 1955–56:

PRESIDENT.

J. A. MACDONALD, Ph.D., D.Sc., F.R.S.E.

VICE-PRESIDENTS.

P. H. DAVIS, B.Sc., Ph.D., F.R.S.E.
B. L. BURTT, B.Sc., F.L.S., F.R.S.E.
J. G. ROGER, B.Sc., F.L.S.
D. M. HENDERSON, B.Sc.

COUNCILLORS.

J. W. GREGOR, Ph.D., F.L.S.
D. H. N. SPENCE, B.Sc.
E. E. KEMP, N.D.H., D.Inst.P.A.
R. M. ADAM, F.L.S.
Miss E. BEATTIE.
Miss C. W. MUIRHEAD.
J. SMITH, D.Sc.
H. R. FLETCHER, D.Sc., F.R.S.E.
Miss M. M. MACDONALD, B.Sc.
Miss P. J. WATSON, Ph.D.

Honorary Secretary—P. S. GREEN, B.Sc., F.L.S.
Assistant Secretary—Miss D. E. PURVES.
Cryptogamic Secretary—D. M. HENDERSON, B.Sc.
Editor—Miss A. M. MACLEOD, Ph.D., Heriot-Watt College, Edinburgh.
Treasurer—R. T. HUNTER, C.A.
Artist—R. EUDALL.
Auditor—C. A. SCOTT, C.A.

The TREASURER, Mr. R. T. HUNTER, submitted the following Statement of Accounts for the Session 1954–1955:

INCOME.

Annual Subscriptions for 1954–1955	£100	10	0
Arrears of Subscriptions recovered	16	5	0
Transactions sold	21	6	7
Interest on Investments	13	7	10
Subscriptions to Publication Fund	3	8	2
Income from Botanical Society Trust Fund	6	1	0
Income Tax recoverable 1954–1955	16	15	2
Grant from Carnegie Trust	100	0	0
	£277	13	9
Excess of Expenditure over Income	137	2	6
	£414	16	3

EXPENDITURE.

Printing *Transactions*, **36**, Part IV (Estimated Sum), say	£325	0	0
Printing and Postages of Notices of Meetings, say	70	0	0
Stationery, Postages, etc.	7	19	5
Fire Insurance on Books	0	5	0
Bank Charges	1	6	10
Honorarium to Treasurer	5	5	0
Honorarium to Assistant Secretary	5	0	0
	£414	16	3

BALANCE SHEET AS AT 30TH APRIL 1955

LIABILITIES.

I. Capital Funds—					
Balance brought forward from 1953–1954				£980	16 8
Add—Life Compositions received in 1954–1955					
Donations	£3	0	0		
				3	0 0
				£983	6 8
Less—Excess of Expenditure over Income 1954–1955				137	2 6
				£846	4 2
II. Subscriptions received in advance—					
1955–1956 A. Currie	£1	0	0		
E. W. Debney	1	0	0		
P. C. De Kock	1	0	0		
				3	0 0
III. Printer's Account Outstanding—					
Printing *Transactions* (Estimated Sum)	£325	0	0		
Notices of Meeting and Postages (Estimated Sum)	70	0	0		
				395	0 0
				£1244	4 2

ASSETS.

I. British Government Securities—				
(*a*) £200 3½% War Stock at cost			£194	18 3
(*b*) £258, 2s. 6d. British Transport 3% Guaranteed Stock 1978–1988 at cost			216	18 6
(*c*) £100 3% Defence Bonds (4th Issue) at cost			100	0 0
(*d*) £100 3½% Defence Bonds (Conversion Issue) at cost			100	0 0
(*e*) £250 3% Savings Bonds 1965–1975 at cost			253	18 3
			£865	15 0
II. Bank Balances—				
(*a*) Sum on Current Account with the Clydesdale and North of Scotland Bank Ltd.	£128	3 2		
(*b*) Savings Account—Union Bank of Scotland Ltd.	22	9 7		
(*c*) Edinburgh Savings Bank Account No. 129	111	1 3		
			261	14 0
III. Grant due from Carnegie Trust			100	0 0
IV. Income Tax Reclaim 1954–1955			16	15 2
			£1244	4 2

EDINBURGH, 29*th May* 1955.—I hereby certify that I have audited the Accounts of the Treasurer of the Botanical Society of Edinburgh for the Session 1954–1955, and have found them correct. I have also checked the foregoing Abstract and found it correct. I have seen the securities for the invested funds and found them in order.

CHARLES A. SCOTT, C.A., *Auditor.*

SIR WILLIAM WRIGHT SMITH LECTURESHIP FUND

SESSION 1954–55

Balance of Fund brought forward from 1953–54				£303	5 6
Interest on £250 3½% War Loan	£4	7	6		
Interest—Edinburgh Savings Bank . . .	2	7	8		
				6	15 2
				£310	0 8
Less Expenses—					
Professor Richards	£7	12	8		
Mr. J. R. Mackay	1	18	4		
				9	11 0
				£300	9 8
Being—					
£250 3½% War Loan at cost . . .	£203	12	0		
Edinburgh Savings Bank Account No. 312	96	17	8		
				£300	9 8

EDINBURGH, 29*th May* 1955.—I hereby certify that I have audited the Accounts of the Sir William Wright Smith Lectureship Fund for the Session 1954–55, and have found them correct. I have seen the securities for the invested funds and found them in order.

CHARLES A. SCOTT, C.A., *Auditor.*

The Secretary, Mr. P. Green, submitted the following Report from Council:

The Membership of the Society stands at present at 303: viz. 9 Honorary British Fellows, 20 Honorary Foreign Fellows, 220 Ordinary Fellows (of whom 88 have compounded for life), 23 Ordinary Members, 30 Lady Members and 1 Associate. During the year, 8 Ordinary Fellows and 4 Ordinary Members have been elected, 2 Ordinary Fellows and 3 Ordinary Members have resigned, and 1 Associate (R. L. Harrow, Godalming, Surrey) and 1 Honorary Foreign Fellow (L. H. Bailey, LL.D., Litt.D., Ithica, New York) have died.

Eight Ordinary Meetings were held during the Session, and, at a Special Meeting on 11th March to which all Scottish Botanists were invited, a number of Fellows were enlisted to assist in compiling records of Scottish Plants for inclusion in the Distribution Maps of British Flowering Plants and Ferns at present being prepared. The usual Cryptogamic Foray was held on 25th and 26th September.

During the Session, informal meetings were held between a sub-Committee of the Council and botanists from the Glasgow area, and, as a result, a Committee was formed to stimulate and co-ordinate work on the Scottish Flora. A Constitution for the Committee was formulated and agreed upon jointly by this Society and the Botanical Society of the British Isles. Each Society nominated three members to serve on the Committee, those nominated by this Society being Miss Ursula K. Duncan, Professor J. R. Matthews and Mr. B. L. Burtt.

The Council hopes in future to institute a section in the *Transactions* devoted to *Notes on Scottish Botany*, and Fellows who have any suitable material, *e.g.* brief notes of biological interest or records of new, interesting or rare plants, are invited to communicate with the Editor.

The Society has again been invited to send delegates to the Assembly of Corresponding Societies at the Meeting of the British Association in Bristol, and the Council has nominated Mr. J. Anthony, Dr. J. A. Macdonald and Dr. Malcolm Wilson as delegates.

Contributions to the Illustration Fund have been received from Miss M. M. Cattanach and from Mrs. Watt and are gratefully acknowledged.

Printing costs continue to rise, and the Council is examining the situation—common to all learned societies—brought about by the increasing costs of publication.

The Council wishes to express the indebtedness of the Botanical Society of Edinburgh to the Carnegie Trust for the Universities of Scotland for a substantial grant towards the publication of this number of the *Transactions*.

TRANSACTIONS

OF THE

BOTANICAL SOCIETY OF EDINBURGH

SESSION CXIX

PRESIDENTIAL ADDRESS.

Some Aspects of Root Study.

By W. Burns.

(Read 15th October 1954.)

I feel that the title of this address ought to have been "Rambling Remarks on Roots", but, to prevent these remarks becoming too incoherent, I propose to pen them, like sheep, into three folds. These are (1) the origin and nature of the root, (2) modifications of the root, (3) agricultural and horticultural practices affecting the root. If occasionally an idea (like a sheep) breaks through the fence between the folds, that is the nature of ideas (and sheep). Perhaps even a stray from another flock may find its way in.

The root is an organ which, being in most cases below ground, is out of sight and also out of mind. But it has not been out of the mind of the human race during its sojourn on this planet. The metaphorical use of the word *root* as noun and verb in the languages of mankind shows this. In Cruden's *Concordance* of the Bible there are fifty-four references containing such words. We ourselves daily employ such expressions as "radically" or "the root of the matter", while the French word for displaced persons is "*déracinés*". The philosophical botanist Cesalpino, in his book which appeared in 1583, divides the plant into two parts, one being "the root, by which they procure food" (*see* Sachs, 1890). This quotation shows his recognition of the importance of the root and also indicates the limitations of his understanding of the functions of the various parts of the plant.

Concerning the time and method of appearance of the root, as a member of the plant body during the course of evolution, there is no

direct evidence. Bower (1908) considered that the root could not itself be held to be a continuation of the primitive axis and believed that the facts pointed to the root being an accessory part upon the embryonic body.

But we go too fast. We are accustomed to work on the assumption that early organisms all came from the sea and that they divided into two lines, one leading to the animal and the other to the vegetable world. So far as those organisms now living on land are concerned, the great difference is that the animals are motile, while the vegetables are static, by virtue of their anchorage. Many plants now in the sea are also anchored, but by holdfasts or crampons, which are believed to have no absorptive function. When plants began to invade the land, it is usually presumed that it was the gametophyte which did so and that it was anchored to the land by rhizoids which had also water-absorbing functions. From one point of view we may perhaps say that the plant had to adapt itself twice to land conditions, once as gametophyte and again as sporophyte.

Bower (*loc. cit.*, p. 673) goes minutely into the embryology of the Lycopods and shows that, after the definition of the polarity of the embryo, the occurrence of the root is commonly lateral, and that its approximation to the axis of polarity is occasional and accidental rather than an inherent character. It would also seem that the occurrence of the root in Lycopod embryos is not definite in level nor in relation to other parts of the embryo, nor in time of appearance in the developmental process. These Lycopod roots are formed endogenously, but there is an exception, namely, the first root of *L. selago*, which is formed exogenously. From Bower's figure (p. 344) it appears that the root arises from a point opposite the termination of the vascular column. This seems to me to be like certain callus-roots of cuttings which appear opposite the cut ends of the vascular bundles. Priestley and Swingle (1929), referring to one of their experiments on cuttings of sea-kale, state that the roots usually appeared in a ring over the site of the original vascular cambium. Other roots were occasionally seen to be arising from the xylem region, but no roots emerged from any point of the surface outside the cambium ring. However that may be, the root is always in close contact with the vascular system of the stem and so in a position to pass on to it whatever it absorbs from the soil.

There is in the Ferns a close connection between roots and leaves, and in the Equisetinae there is a root initial at the base of each leaf.

In 1919 A. H. Church published a paper in which he argued that

there had been a direct progression from the sea to land. He opined that, as the land masses were pushed up above the water, they carried with them the plants already growing, and that many of the forms previously submarine changed into forms capable of growing on land. At one point he says: "It is thus from the standpoint of food-salt supply that any transmigration, to be effectual, demands the initiation of a basal absorptive mechanism, and the initiation of an upward direction of conduction in the axis; the water-problem may be at first quite immaterial." He points out that at first the exposed sea-bottom would have no soil and that this gradually accumulated from plant debris no longer washed away, and (in his own words) "this gives the first initiation of an organic substratum, from which it would be possible to absorb the physically-retained water and salts and so gradually perfect the mechanism of the 'root' and from which the living complex termed 'soil' has been also gradually evolved". The root, so far as I can gather, was, in Church's opinion, developed from the crampon-like attachments of the more massive, more resistant, more perennial stocks of marine phyto-benthos.

Arber (1950), from the morphological point of view, considers that the leaf is a partial-shoot revealing an inherent urge towards a whole shoot but never actually attaining that goal. Arber asks, "Is it possible to regard the root . . . also, as a partial-shoot, but one that derives its partialness from a different set of deprivations from those suffered by the leaf?"

Arber's arguments and suggestions have been the subject of criticism, and the suggestion that the root is a partial-shoot seems to me an unnecessary attempt to class all the organs of the plant as of one category, the shoot. Bower's inference that it is an appendage on the shoot, developed for a special purpose, seems more reasonable, and perhaps the power possessed by so many plants of developing adventitious roots on stems and even leaves may be a relic of its evolutionary origin.

Talking of adventitious roots brings me to the ideas (or sheep) in my second pen, and mention may be made of a paper by Borthwick (1905) on "Birds-Eye Formation (Maser-Holz) in the Wood of Various Trees". He quotes Strasburger (1903) to the effect that Curled or Bird's-Eye Maple owes its origin to "the unusually sinuous course taken by the elements of the wood", which he attributes to the production of numerous adventitious buds and also to the formation of abnormally broad medullary rays round which the wood elements are forced to bend and thus deviate from their usual

course. No mention is made of these being rhizogenous. Borthwick found that the medullary rays of species of *Cupressus*, of *Acer*, apple and elm might become broad and cylindrical and be continued out into adventitious roots, and also that such abnormal medullary rays and adventitious roots might be produced abundantly on the burrs found on elm and rowan. In a Wych-elm burr he found shoot-buds and root-rudiments side by side.

Priestley and Swingle (*loc. cit.*, p. 26) mention a case where root and shoot apices were organised very close to one another within the parenchyma near the cut surface of a root of *Cichorium intybus*. Here shoot and root meristems must have originally come (they say) from groups of cells that were close to one another.

This juxtaposition of bud and root initials can be paralleled in an experiment by Fischnich (1938), who split a branch of *Populus nigra* var. *pyramidalis* at the apex, kept it in 0·003 per cent. solution of heteroauxin, then put it in tap-water and treated one of the cut ends with 0·125 per cent. heteroauxin paste, leaving the other cut end untreated. After fourteen days the treated end produced roots and the untreated end produced shoots. It is possible to think that in the Wych-elm burr there may have been similar differences in hormone concentration between adjacent areas.

Goebel's *Einleitung in die experimentelle Morphologie der Pflanzen* shows cases of root and shoot initials side by side, as, for example, at the basal end of a two-leaved cutting of *Achimenes hirsuta* (p. 231; fig. 122).

In many plants, adventitious roots play a great part in the plant's life and structure. Certain genera of mangrove, for example, such as *Rhizophora*, are balanced on stilt roots which give them an elastic perch above the muddy tidal waters in which they live, giving little resistance to the flowing tides. *Rhizophora* also has the curious adaptation of dropping its weighted half-developed seedling vertically into the mud, ready to continue growth. I have seen this tree in the southern part of the Bombay State. Just north of Bombay, in the muddy creeks, there is to be found *Avicennia alba*. This produces pneumatophores or breathing roots, which, like the diver's air-tube, carry air to the submerged parts. This is one example of a root growing with negative geotropism.

Buttress-roots are found regularly on certain tropical trees and may form great flanges radial to the trunk. I do not know whether their anatomy has been thoroughly worked out, and to what extent these buttress-roots (so-called) are root and to what extent part of the trunk. I have noticed in India that the formation of buttress-

roots occasionally occurs in species that do not usually form them, such as *Acacia arabica*. This is similar to the occurrence of the weeping habit (which we associate with some trees, such as the willow) in other genera and species not related with each other, such as the Weeping Cherry (*Prunus serrulata rosea*) (Cook, 1952).

The genus *Ficus* has many species, including the edible fig with its curious method of pollination and its variable leaf shape, and the lordly banyan, *Ficus bengalensis*, with its adventitious roots hanging from and finally supporting the nearly horizontal branches. When planted as roadside trees in India these hanging roots often never reach the ground but finish off about 4 ft. from it. Every year when the rains come the lower ends of these stumps put out slender roots in an attempt to complete the earth connection. Just as quickly are they eaten off by wandering goats. Willis (1897) mentions that in India the roots may be provided with bamboo tubes to protect them and the ground prepared for them. I have not seen this done, but the plate in Engler's *Naturliche Pflanzenfamilien*, which Willis quotes, shows several roots which have finished up in small stone enclosures, obviously made for them. Certain *Ficus* species, including the banyan and also the sacred fig-tree (*F. religiosa*), can root in crevices of masonry, finally disintegrating the stoutest wall. North of Bombay lies the old Portuguese fort of Bassein, with a wall about three miles round and containing the ruins of thirteen churches. In my time the wall and the churches were riddled with *Ficus*. *Ficus* trees were also a menace to the masonry of wells in India if once they gained a lodgment. The only way we could get rid of them was to inject a solution of sodium arsenite into the trunk. The whole plant then died and could be pulled out like a loose tooth.

The amazing vitality of *Ficus* was also visible in another way near the same Bassein. The railway approaching it had to cross a broad tidal creek on a bridge. The iron pillars of a previous bridge had been left alongside it. The tops of these pillars had some scroll-work on them and in it seeds of *Ficus* had lodged. When I saw them the seeds had developed into small trees, 3 ft. high, though nourished by nothing except the steamy atmosphere and the rain. In the hot weather the pillars must have been exceedingly hot, yet the plants lived.

Captain Cousteau (the French naval diving expert) mentions (1953) an old fig-tree growing high up on the vertical wall of an inland water-cave near Avignon, which apparently gets its roots watered only once a year during the annual flood in March.

Certain tropical trees use their adventitious roots for the purpose of growing up on other trees, which they often eventually strangle. Julian Duguid, in his sixth and last talk on "Ten Days in Brazil", in the Home Service of the B.B.C. on 14th February 1954, mentioned being taken to see what looked like a tree of this kind near the town of Belem. The fact is that the tree has engulfed the chimney of an old sugar-cane factory. Soon after hearing his talk I came across a photograph of this same tree in the *Scientific American* of January 1954. In that issue there is also an excellent photograph of an early stage of the encirclement of a tree by the strangler tree *Clusia* (Guttiferae). The writer (Dobzhanzsy, 1954) states that *Clusia* does not kill the tree, but Willis (1897) says it frequently strangles its support altogether.

From epiphytes and stranglers it is not a far cry to root parasites. In India a species of *Orobanche* (*O. nicotianae*) is a serious pest of tobacco. *Orobanche* seems to have no leaves, and the above-ground part is a large inflorescence or series of inflorescences producing millions of tiny seeds. Once a tobacco field is infested with *Orobanche* there is, so far as I know, nothing one can do but to cease growing tobacco on it for many years, for we do not know how long the pest's seeds will remain alive in the ground. Careless cultivators used to cut off the inflorescences and leave them lying in a heap at the edge of the field, thus spreading the disease. The correct thing is, of course, to burn them.

Another phanerogamic root parasite in India is *Striga* (belonging to the *Scrophulariaceae*), of which there are several species. Wild grasses, sorghum and sugar-cane are among their hosts. They are small plants with rather pretty yellow flowers. I believe no remedy has yet been found against them.

The mention of *Striga* always brings to my mind an extreme example of faith in figures and at the expense of facts. I was inspecting a randomised field-experiment in a certain experimental station in India. The man in charge told me complacently that the experiment was inconclusive because the experimental error was so large that no real significance would be attached to the results. A short examination of the field revealed (1) that germination of the crop had been irregular, some plots having germinated well, others badly; (2) there was a marked edge-effect, the outside of the plots on the boundaries of the experiment being much better grown than any of the inside plots; and (3) some plots were badly affected by *Striga* and others unattacked. It was no wonder, then, that there was a huge experimental error, completely wiping out the differences

between varieties or treatments. That came of being drunk with the new wine of statistical significance!

Man in the course of his long history has found various ways of exploiting the roots of plants. Apart from growing those which become swollen sources of food, his efforts have been mainly (1) a manipulation of the main root-system so as to effect the rhythm of life of the whole plant, and (2) an exploitation of the power of the plant body (mainly the stem or parts of it) to produce adventitious roots.

As an example of the first, I may mention a practice that used to obtain in the orange-growing districts round Poona in the Bombay State. The orange trees could be made to flower at one of two seasons, *i.e.* so as to produce fruit ready in December (for the Christmas trade) or in April (for the hot weather trade). The practice was, eight months before the fruit was wanted, to expose the roots round the tree to a radius of about 4 ft. and cut off irrigation for about three weeks. The method of exposure was crude, the digging tool used being the common digging instrument of the East (variable in form), but with one common character, namely, that one does not "dig" with it but, to use the Scots term, one "howks". The roots were often badly hacked in this process, and this damage may have been at least a contributory cause of the die-back disease so common in these gardens, in which the end-twigs and finally whole branch-systems dried up, the tree meanwhile making desperate efforts to renew itself by putting out suckers lower down.

Another example (though hardly in either class of root exploitation) was that of the treatment of the roots of the cotton plant remaining in the ground in the northern part of the Bombay State. After the cotton crop was harvested, the dry stems were usually cut and used for fuel, but very often the underground part remained alive and sent up young shoots in the hot weather. These formed an ideal place for passing this season for the grubs of the *Earias* species commonly known as the Spotted Bollworm, which spoiled much cotton by boring into the growing cotton-fruits. These pests normally passed the season between cotton crops on Malvaceous weeds, but if one eliminated such weeds there was still the growth from the cotton roots to deal with. The Bombay Agricultural Department devised a cotton stump-puller, rather like a magnified version of the tool used for pulling nails out of packing cases. This did the trick so far as the Bombay State was concerned, but was inadequate for the Punjab where the plants were much stouter.

As regards the exploitation of the power to produce adventitious

roots, examples are numerous. I may perhaps choose one or two of the less well known.

In India, a universal practice is the chewing of *pan*. The word pan literally means *leaf*, and the leaf used is that of *Piper betle*. (The leaf is used as the wrapper for shredded betel-nut (from *Areca catechu*), to which are added cardamoms, cloves, a touch of slaked lime, and other things.) The plantations of *Piper betle* are complicated affairs, with the plant growing on live supports and thoroughly shaded. At a certain period of the year the vines are taken down, coiled into a figure of eight and buried in the soil. From these buried coils there descend into the soil the adventitious roots and into the air rise the shoots of the new plants.

Something very similar, I believe, is done with hops. Priestley and Swingle (*loc. cit.*, p. 56) state that the stem is buried in a screw-shaped coil with the lower portion of the coil in the ground and the upper part out of it. The exposed portion shrivels, the buried part remains swollen and, in the spring, vigorous endogenous root-production takes place from the neighbourhood of the cambium, while the swollen shoot becomes covered with adventitious buds.

The sugar-cane is normally propagated by planting pieces of the cane. The practice which the Bombay Agricultural Department used to advocate was to use pieces of three nodes with the buds placed sideways so that all could sprout. At the base of each internode of the sugar-cane is a zone full of little points, every one of these an incipient root. In addition, most varieties of sugar-cane (some more than others) put out aeriel roots, from these same areas, which serve to anchor and steady the tall stem. The same phenomenon of additional aerial roots acting as guy-ropes can be seen in maize and sorghum. It is quite possible to induce similar roots in cuttings of *Jasminum nudiflorum* grown in summer in a cold frame, if you make the atmosphere moist by keeping a glass jam-jar over the cutting. Such roots grow till they reach the substratum, and you have a new plant with miniature anchoring guy-ropes.

Bouillenne and Went (1933) state that in the palms the foliar bundles end in *culs-de-sac*, which may either continue into adventitious roots or perhaps, as in the case of *Iriartea exorrhiza*, terminate in root-spines.

Recently I was reading a book called *Farming in Finland* (Mead, 1953). The author remarks: "In fact the Finnish claylands, in contrast to those of W. Europe, do not provide satisfactory permanent grass for grazing. Adjustment of grasses to heavy soils

through improved root systems may offer a solution". Here we have the root offered as an organ for the attention of plant-breeders. I am sure the grass-breeders at Aberystwyth have not neglected this aspect of their problems.

In this consideration of the root I have briefly touched upon its origin and our ignorance of it. As to its primary purpose we may have little doubt. It has later been modified (as have other plant-parts) as additional external supports, as places for food storage, as organs used for climbing, strangling and parasitism. Most of such organs are adventitious roots. The mere presence of adventitious roots is a perpetual question mark. Their value in propagation man has recognised and utilised for thousands of years. Their evolutionary status will probably never be settled.

Concerning the circumstances of their production in nature and in experimental situations (including culture of plant fragments *in vitro*) we have a mass of data, but as yet no coherent theory, though there have been several attempts at partial hypotheses. This region of plant physiology, which has been perhaps regarded as rather too horticultural to merit the attention of some physiologists, awaits interpretation from someone acquainted with the vast amount of information available, and able to trace in it some co-ordinating principle.

In concluding this address I have the same kind of relief as that felt by Robert Louis Stevenson in his Scots poem entitled "Their Laureate to an Academy Class Dinner Club". Stevenson was, as you know, educated at Edinburgh Academy. He was supposed to write a poem each year for the annual class dinner. Apparently he had not done so for some time, and this poem is an outburst to make up for his previous neglect. He compares himself, bestriding his Muse, to a small boy sent off on an urgent errand mounted on a spirited farm-horse, with similar difficulties. If those of my audience to whom the Lowland Scots tongue is unfamiliar will tolerate the quotation, his last verse expresses my own feelings:

". . . But at the least,
The day I've backed the fashious beast,
While she, wi' mony a spang an' reist,
Flang heels ower bonnet:
An' a' triumphant—for your feast,
Hae! there's your sonnet!"

References.

Arber, A. (1950). *The Natural Philosophy of Plant Form.* Cambridge University Press, p. 131.

Bouillenne, H., and Went, F. (1933). Recherches Expérimentales sur Néoformation des Racines. *Ann. Jard. Bot. Buitenzorg,* **43,** 176.

Borthwick, A. W. (1905). *Notes from the Roy. Bot. Gard. Edinb.*, **4**.

Bower, F. O. (1908). *The Origin of a Land Flora.* Macmillan.

Church, A. H. (1919). *Oxford Botanical Memoirs,* No. 3.

Cook, L. J. (1952). The Weeping Habit. *American Gardener*, p. 16.

Cousteau, J. Y. (1953). *The Silent World.* Hamish Hamilton.

Dobzhanzsy, T. (1954). Strangler Trees. *Sc. American*, p. 78.

Fischnich, O. (1938). Die Rolle des Wuchsstoffes bei der Bildung von Adventivsprossen und Wurzeln. *Ber. dtsch. bot. Ges.*, **56,** 144.

Mead, W. R. (1953). *Farming in Finland*, p. 109.

Priestley, J. H., and Swingle, C. F. (1929). Vegetative Propagation from the Standpoint of Plant Anatomy. *U.S.D. Agric. Tech. Bull.*, No. 151.

Sachs, J. (1890). *History of Botany.* Eng. Trans. by Garnsey and Balfour. Oxford University Press.

Strasburger, E. (1903). *Textbook of Botany.* 2nd Eng. ed.

Willis, J. C. (1897). *Flowering Plants and Ferns*, **2,** 160.

The Flowering Plants and Ferns of the Isle of May, Firth of Forth, Fife (v.-c. 85).

By W. J. Eggeling.
(The Nature Conservancy, Edinburgh.)

(Read by title, 15th December 1955.)

The recent paper by E. V. Watson (1953) on the bryophyte flora of the Isle of May contains a good general description of the island: additional details concerning its history, topography, etc. can be found in many publications, but sufficiently, for the present purpose, in the papers by J. Rattray (1886) and G. West (1910). A helpful vegetation map, based on field work by H. G. Callan (whose detailed manuscript notes are deposited in the records of the Isle of May Bird Observatory and Field Station), illustrates the paper by H. N. Southern (1938) on its vertebrate fauna. The geology of the island is dealt with fully by A. Geikie (1902) and, more concisely, by J. A. Steers (1953).

The first published account of the island's flowering plants and ferns is that of J. Sadler (1872). It contains a list of the plants which he and Professor J. H. Balfour observed on the island in the course of a two-hour stay on 11th August 1871, when the British Association visited the May. Additions were made to Sadler's list as a result of visits by Rattray in 1884, West in 1905 and W. Evans (1911) in 1910 and 1911. Since then, nothing has been published on the flowering plants and ferns of the island, and the object of the present paper is to bring the picture up to date.

Antedating Sadler's account by over fifty years is an unpublished note made for Robert Stevenson by D. Don (1819) on the possibility of afforesting certain parts of the May. The original of this report, written from Leith Walk Nurseries on 27th August 1819, is the property of D. Alan Stevenson, brother-in-law of Comdr. T. Yeoman, R.N. (rtd.), through whose courtesy a copy has been made available for the records of the Bird Observatory. Although Don's remarks on the indigenous vegetation are mainly confined to listing the principal pasture-forming grasses and some of the rushes and sedges, he does note the presence of sea-pink and of "tall-growing weeds such as hemlock, dock, etc." (in the Chapel area). From this, it would seem that the vegetation in 1819 was much the same

as when Sadler wrote. This is indeed only what one would expect, because for well over 300 years the Isle of May has been inhabited regularly only by lighthouse-keepers and their families, and it can have altered but little in that time. During the two world wars of the present century troops were stationed on the island, but their activities had no material effect on the phanerogamic vegetation. Such vegetational changes as have occurred during the past hundred years must be due chiefly to the reduction in the acreage under cultivation, the cessation of grazing by sheep and increased grazing by rabbits—though it is to be noted that, according to J. Ritchie (1920), the latter were abundant on the island at least as long ago as 1329. Just before Sadler's visit, as recorded by T. S. Muir (1868), the three lighthouse people were cultivating about two acres of barley, potatoes, turnips, cabbages, onions, etc., and there were on the island three milking cows and some sixty sheep. Not long afterwards, in 1884, the stock had risen to sixty sheep, six cows, a Clydesdale horse and three donkeys (A. J. Harvie-Brown, 1887). Now, in 1955, the four keepers and their families cultivate less than a quarter of an acre between them; there are two goats on the island but no other stock.

The present is a particularly opportune moment to make a re-assessment of the status of the plants of the May. Early in the spring of 1955 myxomatosis made an appearance on the island—probably introduced by gulls—and by the end of August it seemed likely that the whole of the large rabbit population had been wiped out. Whether this is in fact the case remains to be seen, but in any event there has been an immediate response by the vegetation to the reduction in grazing, and far-reaching changes in its composition are to be expected.

Comparing the lists of Sadler, Rattray and Evans with that of the present day, it is noticeable that most of the species which no longer occur on the island are plants associated with cultivation. The disappearance of a number of others, e.g. *Mertensia*, is less easy to explain. Recent additions to the island's flora are probably as much the result of more intensive study, at all seasons of the year, as of an actual increase in the number of species present. Several of the new additions are casual annuals, present one year, absent the next: the probability is that most of these owe their introduction to birds.

In the list which follows, all those plants reported from the island prior to the end of 1911 and not recorded from it between 1937 and the end of 1955 are enclosed in brackets; doubtful or disproved

records have been placed in square brackets. Plants marked with an asterisk have not, so far as can be traced, been reported in print from the island before.

The records for 1947 to 1955 derive from three main sources: (i) the daily log books and other records of the Bird Observatory; (ii) a collection of flowering plants and ferns gathered on the island in 1947 and 1948 by R. W. James and deposited in the Herbarium of the University of St. Andrews; and (iii) my own observations in 1949, 1952, 1954 and 1955. Cultivated plants, garden escapes and deliberate introductions are not listed, the last category including, amongst others, kingcup (*Caltha palustris*), yellow flag (*Iris pseudacorus*), primrose (*Primula vulgaris*), cowslip (*P. veris*), monkey flower (*Mimulus guttatus*), elder (*Sambucus nigra*), tree mallow (*Lavatera arborea*), spring squill (*Scilla verna*) and sycamore (*Acer pseudoplatanus*). Although probably introduced unintentionally by a bird, I include in this category the specimen of cultivated fig (*Ficus carica*) which is growing from a rock crevice in a gully near the Low Light.

ANNOTATED LIST.†

7. Polypodiaceae.

Asplenium marinum L. Not uncommon in caves and on the cliffs. E. 7057.

(A. ruta-muraria L. A very scarce fern in 1905, according to West. No other record.)

Athyrium filix-femina (L.) Roth. Rare. Recorded by Rattray in 1884; collected again by James in 1947.

[Cystopteris montana (Lam.) Desv. Shown on Southern's vegetation map as occurring in 1936, but from Callan's distribution sketches it is certain that *Dryopteris dilatata* was the plant involved.]

Dryopteris dilatata (Hoffm.) A. Gray. Described by Evans as "a small form, such as one meets in the hills", amongst grass on low rock ledges. This is exactly how it occurs to-day. E. 7049.

(Polypodium vulgare L. Evans found a good-sized patch in 1910 on the steep bank south of the loch. It had been "sadly spoiled by excursionists in the belief that it was the sea-spleenwort". No other record.)

10. Ophioglossaceae.

*Ophioglossum vulgatum L. ssp. vulgatum. Rare; one colony only. First recorded in 1954. E. 7042.

---

† The nomenclature and arrangement of this list agrees with that of Clapham, Tutin and Warburg (1952) except for the naming of *Dryopteris*, *Montia*, *Peplis*, *Rumex* and *Catapodium*. The citation of a collecting number indicates that I have collected a plant myself and that a herbarium sheet has been deposited in the records of the Isle of May Bird Observatory and Field Station.

14. Ranunculaceae.

(Ranunculus acris L. Found in 1871 by Sadler. Not reported since.)
R. repens L. Very common. E. 7034.
R. flammula L. ssp. flammula. Abundant in damp parts of the Holyman's Road. E. 7033.
*R. hederaceus L. Common in marshy puddles in the Holyman's Road near the Low Light; occurs also elsewhere. E. 7115.
R. aquatilis L. emend. Two records only. West noted "rather dwarf specimens" in 1908, though all his *aquatilis* records are subject to a remark that it was not always possible for him to distinguish the exact species of Batrachian Ranunculi which he encountered on his travels. Canon A. K. Hervey (Bird Observatory records) is certain that one of the larger Water Crowfoots was present in 1952, but I have not seen it myself.
R. ficaria L. Locally abundant. First reported by Evans in 1910. E. 7035.

19. Papaveraceae.

*Papaver rhoeas L. A few plants on the North Ness, 1955. E. 7142.
*P. dubium L. Common in the Top Garden; also a few plants on the North Ness (1955). E. 7133.

20. Fumariaceae.

Fumaria officinalis L. Casual. Recorded from one of the gardens by Evans. Still present (Low Garden and Bain Trap), 1955. E. 7135.

21. Cruciferae.

(Brassica nigra (L.) Koch. Listed in 1871; only record.)
Sinapis arvensis L. Listed in 1871 by Sadler; still present on the North Ness and elsewhere. One specimen (E. 7164) has a remarkably tough and thickened replum, not precisely matched in any material of this species at Kew. E. 7131, 7141, 7164.
*Raphanus maritimus Sm. A few plants on the North Ness and elsewhere in 1955. E. 7162, 7166.
(Cakile maritima Scop. Listed in 1871; only record.)
(Coronopus squamatus (Forsk.) Aschers. Reported from near the lighthouse by Sadler, who noted that it had probably been introduced. No other record.)
Thlaspi arvense L. Listed in 1871; a few plants in the Low Garden in 1955. E. 7171.
Capsella bursa-pastoris (L.) Medic. Common in the gardens in 1911; still so in 1955. E. 7048.
Cochlearia officinalis L. Not infrequent in suitable sites. E. 7059.
C. danica L. Abundant; much commoner than *C. officinalis*. E. 7003.
*Sisymbrium loeselii L. Two plants at the south-eastern entrance to the Tower, early August 1955. E. 7150.

23. Violaceae.

Viola riviniana Rchb. ssp. minor (Murbeck) Valentine. Seen by Evans, in 1911, two years after the lighthouse-keepers had first noticed it. Still present; locally abundant. E. 7000, 7124.

*V. TRICOLOR L. (or V. ARVENSIS Murr.). According to the Bird Observatory Log, P. R. Booth saw a single pansy plant in 1952 near the tern colony on the North Ness. No other record.

30. CARYOPHYLLACEAE.

SILENE MARITIMA With. Abundant. E. 7050.

(MELANDRIUM RUBRUM (Weig.) Garcke. A group of less than a dozen plants was seen by Evans in 1910 and 1911 on the steep bank south of the loch. Not reported since.)

CERASTIUM VULGATUM L. Common. E. 7022.

C. TETRANDRUM Curt. Common. The first published record for Fife is the "Isle of May, D. Don" of Greville (1824). Reported also by Sadler and West, and still present to-day. E. 7023.

(C. SEMIDECANDRUM L. Sadler's 1871 record is the only one.)

STELLARIA MEDIA (L.) Vill. Common in the gardens. E. 7047.

[SAGINA APETALA L. Reported by West without mention of any other species: a doubtful record.]

S. MARITIMA Sm. Common. E. 7070.

S. PROCUMBENS L. Abundant. E. 7071.

(MINUARTIA VERNA (L.) Hiern. Listed by Sadler (as *Alsine tenuifolia*). Callan noted probably the same species in 1936. No other records.)

(ARENARIA SERPYLLIFOLIA L. Listed by Sadler; no other record.)

*SPERGULA ARVENSIS L. Collected in 1947 by James from the North Ness, where a few plants were seen again by P. R. Booth in 1952 (Bird Observatory Log). One plant was found on the North Plateau, and a few in the Low Garden, in 1955. E. 7173.

SPERGULARIA SALINA J. & C. Presl. Listed by Sadler (as *S. rubra*). One plant on the North Plateau, 1955. E. 7173.

31. PORTULACACEAE.

MONTIA FONTANA L. ssp. FONTANA. First recorded by Rattray. Not uncommon in ditches and trickles. E. 7043.

32. CHENOPODIACEAE.

(CHENOPODIUM ALBUM L. Recorded by Sadler in 1871. The plant may well have been the var. *viride*, i.e. *Ch. suecicum*.)

C. SUECICUM Murr. First collected by Sim—see Young (1936)—but probably on the island in Sadler's time (see above). Abundant in the Low Garden in 1955. E. 7174.

*C. MURALE L. First collected (in the Low Garden) in 1954; abundant there in 1955. E. 7121.

C. RUBRUM L. First collected by Professor R. J. D. Graham in 1947 (specimen in Herb. St. Andrews). Not infrequent on paths and in the old fields. E. 7068.

[BETA VULGARIS L. ssp. MARITIMA (L.) Thell. There is no satisfactory record of this plant from the island.†]

---

† Both *Beta maritima* L. (i.e. *B. vulgaris* L. ssp. *maritima* (L.) Thell) and *Lavatera arborea* L. are recorded by William Young (1936) as having occurred on the Isle of May, on the authority (both species) of Sir Robert Sibbald (1710) and (*Lavatera* only) the *New Statistical Account* (3, 1845). K. N. G. Macleay (1953) not only copies the *Lavatera* record but appears to endorse it by adding "still there, 1939". In fact, Sibbald nowhere states that either *Beta* or *Lavatera* occurs on the May,

Atriplex littoralis L. Listed by Sadler in 1871; a few plants on the North Ness in 1955. E. 7176.
A. patula L. First noted by Sadler. Common in the gardens. E. 7065.
A. glabriuscula Edmonst. var. babingtonii (Woods) Moss & Wilmott. Known since 1871. Abundant, especially on the North Ness. E. 7063, 7064, 7067.

36. Malvaceae.

[Lavatera arborea L. Still persists from two deliberate introductions between 1920 and 1938, and one in 1955. No satisfactory record of any earlier occurrence.†]

49. Papilionaceae.

Trifolium repens L. Very common. E. 7063.
T. dubium Sibth. First recorded by Sadler in 1871 (as *T. filiforme*). A few plants near the Bain Trap in 1952. Not seen since.
Lotus corniculatus L. First noted by Sadler; there are two big patches in the Cross Park. E. 7037.
*Vicia angustifolia (L.) Reichard var. bobarth (Forst.) Koch. Collected by James in the Holyman's Road in 1947. Not reported since.
(V. lathyroides L. Recorded by Evans "in some abundance in front of the lighthouse" in June 1910, and on a bank near the harbour in June 1911. Not reported since.)
*Lathyrus pratensis. A small patch of several plants in the Holyman's Road in 1955. E. 7160.

50. Rosaceae.

Potentillia anserina L. Common. E. 7028.
P. erecta (L.) Räusch. Common. E. 7027.
(Aphanes arvensis agg. Listed by Sadler; no other record.)

51. Crassulaceae.

Sedum anglicum Huds. Common: known from the island since 1825 (first Fife record). E. 7020.
(S. acre L. Recorded by Sadler; sought in vain by Evans in 1910–11. No other mention.)

59. Lythraceae.

*Peplis portula L. var. portula. Well established in muddy pools and ditches in the Low Light area. E. 7030.

---

though he records them from other islands in the Forth. Furthermore, the reference in the *New Statistical Account* to *Lavatera* is to a plant in a garden at Fifeness only, and not to both the Isle of May and Fifeness, as Young's punctuation can be taken to imply and as Macleay has read him to mean.

Macleay's statement that *Lavatera* was present on the May in 1939 is therefore the only authentic record we have of either plant growing there, and it is clear from local inquiry that his *Lavatera* plants were not native but owed their origin to one of two deliberate introductions from the Bass Rock, the first made by a lighthouse-keeper some years after the 1914–18 War, and the second about 1935 to provide cover for the bird traps.

62. Onagraceae.

*Epilobium montanum L. Noted in the Bird Observatory records to have occurred in 1953; a few plants present in the Top Garden in October 1955. E. 7177.

*Chamaenerium angustifolium (L.) Scop. Reported for the first time by Canon A. K. Hervey in 1952 (Bird Observatory records). A number of small plants were seen in the Fluke Street area in August 1955. E. 7145.

65. Callitrichaceae.

Callitriche stagnalis Scop. First recorded by West in 1905. Very common in most of the freshwater pools and puddles. E. 7057, 7118, 7119.

(C. verna L. emend. Lönnr. Reported by Sadler in 1871 and by West in 1905. Although West lists both *stagnalis* and *verna*, it is possible that only one species as now conceived was involved.)

70. Hydrocotylaceae.

*Hydrocotyle vulgaris L. First recorded by Callan in 1936; the same patch still present in 1954. E. 7026.

71. Umbelliferae.

Conium maculatum L. In gardens and trapping fields. E. 7009.

Apium graveolens L. Evans (1911) refers to specimens in his herbarium collected from the Isle of May in 1879. The only other record is of a gathering by James in 1947.

A. inundatum (L.) Rchb. f. Well established. First recorded by Sadler in 1871. E. 7004.

Ligusticum scoticum L. Very common on the steep, north-facing banks which it favours. Known from the Isle of May since the eighteen-twenties. E. 7052.

Heracleum sphondylium L. First noted by Don in 1819. Common in the Chapel area and trapping fields. E. 7051.

74. Euphorbiaceae.

*Euphorbia helioscopia L. A few plants in the Low Garden in 1955. E. 7168.

(E. peplus L. Evans found a good many plants in the Low Garden in 1911. Not reported since. Confusion with *E. helioscopia* is perhaps possible.)

75. Polygonaceae.

Polygonum aviculare agg. First recorded by Sadler; still present in the gardens. E. 7029, 7147, 7148.

*P. persicaria L. Collected by James in 1947; a number of plants were seen on the North Ness and South Plateau, and in the Low Garden, in 1955. E. 7165.

*P. convolvulus L. A few plants in the Low Garden, 1955. E. 7169.

[Rumex acetosella L. Recorded by Sadler only. As he did not mention *R. acetosa*, which has been reported by every observer since and is one of the commonest species on the island, it seems more than probable that an error, possibly of transcription, is reflected in his list.]

R. acetosa L. ssp. acetosa. Abundant. E. 7015.

R. crispus L. Common. E. 7012.

R. OBTUSIFOLIUS L. ssp. AGRESTIS (Fries) Danser. First recorded by Sadler. Occurs in the gardens. E. 7019.

[R. CONGLOMERATUS Murr. Reported by West only. On distributional grounds the record requires confirmation.]

76. URTICACEAE.

URTICA URENS L. Some big stands on waste ground. E. 7014.

U. DIOICA L. About the Low Light, etc. E. 7013.

89. PLUMBAGINACEAE.

ARMERIA MARITIMA (Mill.) Willd. Abundant. E. 7005.

90. PRIMULACEAE.

ANAGALLIS ARVENSIS L. ssp. ARVENSIS. Casual. Two or three plants were seen by Evans in 1911. A few are growing in the mouth of the Bain Trap, possibly introduced in bird-seed. E. 7031.

GLAUX MARITIMA L. Common. E. 7061.

97. BORAGINACEAE.

*LYCOPSIS ARVENSIS L. First recorded near the Tower in 1952; a few plants at the same place and elsewhere in 1954 and 1955. E. 7040.

*MYOSOTIS ARVENSIS (L.) Hill. Common on old cinder dumps and other waste ground. First recorded by Callan in 1936. E. 7024.

(M. DISCOLOR Pers. Recorded (under the name *versicolor*) by Sadler. Not reported since.)

(MERTENSIA MARITIMA (L.) S. F. Gray. Reported by Sadler to occur sparingly below the lighthouse; sought but not found by Evans in 1910–11. Sadler's record was apparently overlooked by Young, who does not list the Isle of May among previous stations of *Mertensia* in Fife.)

*ECHIUM VULGARE L. One plant near the Ringing Hut, 1954; a small group on the North Ness in 1955. E. 7011.

98. CONVOLVULACEAE.

CONVOLVULUS ARVENSIS L. Found by Evans in 1910 and 1911 in the Low Garden, where it had been present for a number of years. Still there and in the Thistle Field, 1955. E. 7016.

99. SOLANACEAE.

(HYOSCYAMUS NIGER L. Noted by Sadler as "frequent, having probably been introduced with seeds or ballast, as it doubtless has been along the shores of the Firth of Forth". Not reported since.)

100. SCROPHULARIACEAE.

(VERONICA ARVENSIS L. Evans states that this was a common garden weed in 1910 and 1911. It has not been recorded since. Confusion with *V. persica* is perhaps possible.)

*V. PERSICA Poir. Common in the gardens and traps. E. 7038.

105. LABIATAE.

*PRUNELLA VULGARIS L. First recorded in 1954—a small colony on the path between the Low Light and the Tower. E. 7010.

LAMIUM AMPLEXICAULE L. Reported by Sadler in 1871. Abundant in the gardens. E. 7154.

L. HYBRIDUM Vill. First recorded by Evans from the gardens. Still present. E. 7144.

(L. PURPUREUM L. Reported by Sadler, perhaps in error for *L. hybridum*; not recorded since.)

*GALEOPSIS TETRAHIT L. Two plants in the Top Trap, 1955. E. 7159.

106. PLANTAGINACEAE.

PLANTAGO MAJOR L. Dwarfed specimens common on roads, tracks, etc. E. 7018.

[P. MEDIA L. Recorded only by Rattray and by West (who did not, however, record *P. major*). As all recent reports of *media* have turned out to refer to *major*, and until the occurrence of the former is definitely confirmed, it seems wisest to treat the early records as doubtful.]

P. LANCEOLATA L. Very common. E. 7025.

P. MARITIMA L. Not reported by either Sadler or Rattray, yet recorded as abundant by West, who omits, however, all mention of *P. lanceolata*: this suggests confusion. *P. maritima* is certainly a rare species on the island now, although there are two small patches near the Tarpot. E. 7139.

P. CORONOPUS L. Abundant. E. 7001.

LITTORELLA UNIFLORA (L.) Aschers. First reported by West as abundant in small pools: equally so to-day. E. 7032.

109. RUBIACEAE.

GALIUM VERUM L. Locally common. E. 7046.

G. HERCYNICUM Weigel. Common. E. 7114, 7138.

G. APARINE L. In gardens and waste places. E. 7062.

114. COMPOSITAE.

SENECIO JACOBAEA L. Common. E. 7054.

S. VULGARIS L. Mostly in the gardens. E. 7056.

BELLIS PERENNIS L. Common. E. 7039.

(ANTHEMIS ARVENSIS L. Reported by Rattray; not recorded since.)

*ACHILLEA MILLEFOLIUM L. Not uncommon in the Tower neighbourhood, 1955. E. 7152.

MATRICARIA MARITIMA L. ssp. MARITIMA. Common in suitable places. E. 7021.

*M. MATRICARIOIDES (Less.) Porter. One plant on the North Plateau, 1955. E. 7153.

CHRYSANTHEMUM SEGETUM L. Evans found a plant in flower in a patch of oats in the Low Garden in 1911. There was a single plant on the North Ness in 1955. E. 7167.

ARTEMISIA MARITIMA L. ssp. MARITIMA. There is a flourishing colony at the south end. Sadler found it in the north and west. E. 7006.

ARCTIUM VULGARE (Hill) A. H. Evans. This is the only burdock presently on the island. It is assumed that the records of *A. minus* (by Sadler) and *A. lappa* (by Rattray) should be referred to this species. E. 7008.

CIRSIUM VULGARE (Savi) Ten. Common. E. 7044.

[C. PALUSTRE (L.) Scop. Noted by Canon Hervey in 1952 (Bird Observatory records). No other record. Placed in square brackets pending confirmation.]

C. ARVENSE (L.) Scop. Abundant. E. 7007.

(CENTAUREA NIGRA L. Recorded by Sadler in 1871; not seen since.)

LEONTODON AUTUMNALIS L. Frequent. E. 7017.

Sonchus arvensis L. First recorded by Sadler. There are several colonies in various parts of the island, especially near the North Horn. E. 7041.
*S. oleraceus L. Occasional. E. 7055.
*S. asper L. In waste places, etc. First collected by James in 1947. E. 7053.
Taraxacum officinale agg. In gardens, beside walls, etc. E. 7072, 7073, 7155.

119. Juncaginaceae.

(Triglochin maritima L. Reported by Sadler: no other record.)

129. Juncaceae.

Juncus gerardi Lois. First recorded by Evans. Common. E. 7075, 7136, 7140.
J. bufonius L. First recorded by Rattray. Common. E. 7077, 7161.
(Juncus acutiflorus Hoffm. Listed by Don in 1819; reported also by West in 1905 as "dwarf forms about the pools but not abundant". No other records.)
J. articulatus L. Noted both by Don and Sadler; still present. E. 7076, 7111.
J. bulbosus L. Reported first by Don; still present. E. 7081, 7163.
Luzula campestris (L.) DC. Recorded first by Rattray. Common. E. 7117, 7129.

133. Orchidaceae.

*Orchis fuchsii Druce. Two plants on the west slope of the Bield, 1955. E. 7143.
*O. purpurella T. & T. A. Steph. A single plant in the Bield, 1955. E. 7127.

138. Cyperaceae.

(Eleocharis acicularis (L.) Roem. & Schult. Reported by Sadler; no other record.)
E. palustris (L.) R. Br. emend. Roem. & Schult. ssp. palustris. First recorded by Rattray. Common in all marshy areas. E. 7078, 7112.
E. uniglumis (Link.) Schult. Reported by both Sadler and West; collected also by James in 1947. Not recorded since.
(Isolepis setacea (L.) R. Br. Reported by Sadler; not recorded since.)
Eleogiton fluitans (L.) Link. First recorded in 1871; still present, confined to a few pools. E. 7082.
Carex distans L. First recorded by Rattray in 1884. There are a few plants to the south of the Kirkhaven. E. 7134.
(C. hostiana DC. Reported (as *C. fulva*) by Rattray in 1884. Not recorded since. Should perhaps be placed in square brackets.)
[C. caryophyllea Latour. Reported by Canon A. K. Hervey in 1952 (Bird Observatory records). No other mention. Placed in square brackets pending confirmation.]
C. nigra (L.) Reichard. Known since Rattray's visit. Common everywhere. E. 7074, 7110, 7128.
C. otrubae Podp. Common in suitable places. First recorded in 1819 (on the assumption that all records of *C. vulpina* should be referred here). E. 7083, 7113.
C. arenaria L. Reported by Sadler in 1871; still present. E. 7079.
(C. ovalis Good. Reported by Don in 1819. No other record. Should perhaps go in square brackets.)

139. GRAMINEAE.

*SIEGLINGIA DECUMBENS (L.) Bernh. First collected by James in 1947; very local. E. 7156.

GLYCERIA DECLINATA Bréb. Common in certain pools and marshy spots. Don's 1819 record of *Poa fluitans* is assumed to refer to this species. E. 7098, 7120.

(FESTUCA PRATENSIS Huds. (or F. ARUNDINACEA Schreb.?). Evans reported two or three plants of *F. elatior* L. on low ground near the harbour in 1911. There is no other record.)

F. RUBRA L., incl. var. BARBATA (Schrank.) Richt. First recorded by Don. The dominant grass. E. 7087, 7088, 7091, 7107.

F. OVINA L. First record, 1871. Much less common than *F. rubra*. E. 7086.

LOLIUM MULTIFLORUM Lam. First recorded by Sadler. A few plants still in the gardens. E. 7116.

L. PERENNE L. First recorded by Sadler. Still present, especially on the paths outside the Top Garden. E. 7149.

PUCCINELLIA MARITIMA (Huds.) Parl. Sadler's 1871 record of *Sclerochloa maritima* is assumed to refer to this plant. Common on the rocks of the North Ness and on some of the stonier paths. E. 7158.

POA ANNUA L. First recorded in 1871. Found chiefly in the gardens. E. 7104.

*P. COMPRESSA L. First collected by James in 1947. Not infrequent. E. 7146.

(P. PRATENSIS L. Recorded by Don in 1819 and Evans in 1911; not reported since.)

P. TRIVIALIS L. First noted by Sadler. Not uncommon. E. 7089, 7101.

[*Note.*—In the absence of specimens I am unable to place Don's *Poa humilis* or Rattray's *P. caesia*.]

DACTYLIS GLOMERATA L. First recorded by Don. There are a few plants in the Top Garden. E. 7099.

*AGROPYRON REPENS (L.) Beauv. A weed in the Top Garden; first collected by James in 1947. E. 7096, 7108.

[HORDEUM MARINUM Huds. In amplification of the "*Hordeum*" on the vegetation map in Southern's paper, it should be noted that Callan's manuscript notes—from which the map was prepared—refer specifically to *H. maritimum* (from a locality due west of Colm's Hole and above the Holyman's Road). This is a record which requires confirmation.]

KOELERIA GRACILIS Pers. First recorded in 1819. Local; found chiefly on the North Plateau. E. 7126.

*ARRHENATHERUM ELATIUS (L.) Beauv. ex J. & C. Presl. There were a few plants in the Top Garden and in the Bain Trap in 1952, and a few just north of the Top Garden in 1955. E. 7106.

HOLCUS LANATUS L. Reported first by Don. Abundant. E. 7100, 7103.

AIRA PRAECOX L. First noted by Sadler. Not infrequent. E. 7085, 7125.

(AGROSTIS CANINA L. Reported by Don and Sadler but not, with certainty, recently.)

A. TENUIS Sibth. Recorded by Don. Frequent. E. 7093, 7105.

A. STOLONIFERA L. (the typical plant and variants). First recorded by Don. Common. E. 7092, 7094, 7095, 7097, 7102.

*PHLEUM PRATENSE L. Collected by James in 1947; no other record.

*ALOPECURUS PRATENSIS L. Collected by James in 1947. There were a few plants near the junction of the Low Road and High Road in 1954; also in a number of other places in 1955. E. 7090.

*A. GENICULATUS L. First reported in 1955, when patches were noted in damp spots in the Holyman's Road, near Ruff Green and on the North Plateau. E. 7157.

ANTHOXANTHUM ODORATUM L. First recorded by Don. Widespread throughout the turf. E. 7123.

NARDUS STRICTA L. First recorded in 1911; still present but local, growing chiefly on the North Plateau. E. 7130.

CATAPODIUM (DESMAZERIA) MARINUM (L.) C. E. Hubbard. First recorded by Rattray (as *Glyceria loliacea*) in 1886. Re-collected in 1955 from the top of the wall surrounding McLeod's Garden. E. 7122.

Acknowledgments.—I wish to thank Professor Callan for his courtesy in making available the manuscript notes covering his visit to the Isle of May in 1936, Mr. J. H. B. Munro for drawing my attention to D. Don's report, Dr. J. A. Macdonald and Dr. M. D. Dunn for facilities in the Herbarium at St. Andrews, and the following specialists for assistance in naming my gatherings of the more difficult groups: Mr. P. Taylor (*Dryopteris*), Dr. R. W. Butcher (*Ranunculus*), Mr. E. Milne-Redhead (*Cerastium*, *Sagina*, *Juncus*), Dr. S. M. Walters (*Montia*), Mr. J. P. M. Brenan (*Chenopodiaceae*), Mr. J. A. Blakelock (*Sinapis* and *Raphanus*), Mr. D. E. Allen (*Peplis*), Dr. G. Taylor (*Callitriche*), Mr. J. E. Lousley (*Rumex*), Dr. W. A. Sledge (*Arctium*), Mr. E. Nelmes (*Carex*) and Dr. C. E. Hubbard (*Gramineae*). I am grateful also to Mr. E. Milne-Redhead, Dr. E. V. Watson and Dr. M. E. D. Poore for some general checking, to Dr. G. Taylor for certain references, and to the Committee of the Isle of May Bird Observatory and Field Station for facilities on the island and for permission to use their records.

REFERENCES.

CALLAN, H. G. (1936). Manuscript Notes on the Flora of the Isle of May (the Basis of the Vegetation Map in Southern—see below).

CLAPHAM, A. R., TUTIN, T. G., and WARBURG, E. F. (1952). *Flora of the British Isles.* Cambridge.

DON, D. (1819). Unpublished Note entitled "Remarks on the Island of May, chiefly relating to the planting of certain portions of it".

EVANS, W. (1911). Further Records of Flowering Plants (Phanerogams) and Ferns from the Isle of May. *Trans. Bot. Soc. Edin.*, **23,** 181.

GEIKIE, A. (1902). *Memoirs of the Geological Survey, Scotland: The Geology of Eastern Fife.* Glasgow.

GREVILLE, R. K. (1824). *Flora Edinensis.* Edinburgh.

HARVIE-BROWN, A. J. (1887). The Isle of May: its Faunal Position and Bird Life. *Proc. Roy. Phys. Soc. Edin.*, **9,** 303.

JAMES, R. W., collected on the Isle of May in 1947–48. His plants are deposited in the Herbarium of the University of St. Andrews.

MACLEAY, K. N. G. (1953). Additions and Emendations to the Comital Flora for Fife and Kinross (v.–c. 85). *Watsonia*, **2,** 398.

MUIR, T. S. (1868). *The Isle of May, a Sketch.* Edinburgh. (Reprinted in MUIR, T. S. (1885). *Ecclesiological Notes on Some of the Islands of Scotland.* Edinburgh.)

NEW STATISTICAL ACCOUNT, **9,** *Statistical Account of Fifeshire* (1845). Edinburgh.

RATTRAY, J. (1886). The May Island. Its Archaeology; its Algoid Flora; its Phanerogams and Higher Cryptogams. *Trans. Bot. Soc. Edin.*, **16,** 115.

RITCHIE, J. (1920). *The Influence of Man on Animal Life in Scotland.* Cambridge.

SADLER, J. (1872). Notes on the Flora of the Isle of May, Firth of Forth. *Trans. Bot. Soc. Edin.*, **11,** 390.

SIBBALD, R. (1710). *The History, Ancient and Modern, of the Sheriffdoms of Fife and Kinross* (edition of 1803). Cupar, Fife.

SOUTHERN, H. N. (1938). A Study of the Vertebrate Fauna of the Isle of May (Firth of Forth). *J. An. Ecol.*, **7,** 144.

STEERS, J. A. (1953). *The Sea Coast.* Collins.

WATSON, E. V. (1953). Observations on the Bryophyte Flora of the Isle of May. *Trans. Bot. Soc. Edin.*, **36,** 165.

WEST, G. (1910). A Further Contribution to a Comparative Study of the Dominant Phanerogamic and Higher Cryptogamic Flora of Aquatic Habit in Scottish Lakes. *Proc. Roy. Soc. Edin.*, **30,** 65.

YOUNG, W. (1936). A List of the Flowering Plants and Ferns recorded from Fife and Kinross (v.-c. 85). *Trans. Bot. Soc. Edin.*, **32,** 1.

Notes on British Species of the Genus Sphacelaria Lyngb.

By David E. G. Irvine.
(Department of Botany, St. Andrews University.*)

(Read by title, 15th December 1955.)

The order Sphacelariales to which this genus belongs is relatively small and well defined, cosmopolitan in distribution, but with its principal centre of diversity in Australasian waters. The less complex members show some affinity to the simpler Ectocarpales, from which the order may well have originated (Fritsch, 1945). Fritsch divides it into four families, Choristocarpaceae, Sphacelariaceae, Stypocaulaceae and Cladostephaceae, all of which are represented in British waters. Of the five genera into which the Sphacelariaceae is usually divided, namely *Battersia*, *Chaetopteris*, *Disphacella*, *Sphacella* and *Sphacelaria*, only *Disphacella* is unrepresented in the British flora. Of the others, *Battersia mirabilis* Rke and *Sphacella subtilissima* Rke are very rare in British waters (or at least have seldom been noted), and fall outside the scope of this paper. *Sphacelaria*, in which *Chaetopteris* has been here included, is a large genus with a world-wide distribution, and is well represented in the British flora, both in number of species and in abundance and wide dispersal of plants.

The algae referable to the genus *Sphacelaria* Lyngb. which grow round the shores of Britain offer many perplexing problems in ecology, taxonomy, nomenclature, life-history and distribution. British material urgently requires re-examination, as pointed out by Parke (1953), in the light of recent work by Waern (1945, 1952), Kylin (1947) and Lund (1950). Knowledge of the British species is at present scanty, confused and contradictory, owing to the many difficulties which their study presents (*cf.* Sauvageau, 1900). For instance, they may vary considerably in colour and growth-form with differing environmental conditions of season or habitat, while plants of the same species but bearing different reproductive bodies may look quite dissimilar. To add to the confusion, two or more similar species frequently occur in mixed tufts or communities, or even in a host/epiphyte relationship.

In the following notes an attempt is made to provide keys and

* Now at School of Agriculture, Cambridge University.

descriptions adequate for identification purposes of all the known British species and infra-specific taxa, and to bring together all published records of distribution, habitat and reproduction of these algae around British shores. While these are to a considerable extent drawn from the sources cited above and in the bibliography appended, they are supplemented by personal observations and conclusions founded on examination of living and preserved material from various parts of the country, of herbarium specimens in the herbaria of the Royal Botanic Garden, Edinburgh, and of the British Museum (Natural History), and studies of plants in their natural habitats, particularly on the shore at St. Andrews, Fife, Scotland. Records made or checked personally have been denoted by an asterisk. Only a small selection of references is given for each species, consonant with the purpose of these notes: for more detailed treatment of other aspects the reader is referred to Reinke (1891), Sauvageau (1900–1914), Oltmanns (1922), and Fritsch (1945).

Sphacelaria Lyngbye 1819.

Plants are small and olive-brown, growing in tufts or as mats of indefinite extent on sand, rock, or other algae, attached by basal discs or by ramifying stolons or rhizoids, superficial or slightly penetrating the substratum. Fronds are filamentous and erect or prostrate, branches few or many, irregular or strictly opposite, of definite or indefinite growth, terminating in a large apical cell (the *sphacèle*) by the transverse division of which growth takes place. Cells are further multiplied by longitudinal divisions, and in many species by secondary transverse divisions. Hairs may be present or absent, and in some species are probably seasonal. Rhizoids may be absent, few or abundant, in some species forming a complete cortication of the older parts of erect filaments.

Reproduction is by unilocular or plurilocular sporangia, or by special modified branches (propagules) which are normally triradiate in the majority of species.

Twelve species are known to occur in British waters; a thirteenth (*S. saxatilis*) requires further verification.

Key to British Species.

(Adapted from the keys of Hamel (1938) and Lund (1950).)

1. Secondary transverse divisions of cells generally absent . . 2 (1)
   Secondary transverse divisions present 9
2. Propagules not known 3
   Propagules of frequent occurrence 4

KEY TO BRITISH SPECIES—*continued.*

3. Erect filaments little differentiated from creeping filaments. Bears unilocular sporangia only . . . . . *S. britannica* (2)
   Erect filaments distinctly differentiated from creeping filaments. Bears unilocular and plurilocular sporangia . . . *S. saxatilis*
4. Propagules with radiating arms 5
   Propagules wedge-shaped 8
5. Propagules biradiate . . . . . *S. furcigera*
   Propagules generally triradiate 6
6. Plants not partly endophytic . . . *S. pennata* (=*S. cirrosa*) (3)
   Plants partly endophytic (rhizoids penetrating host tissues) . . 7
7. Growing on *Cystoseira* spp. (not *C. fibrosa*). Rhizoids rather sparse *S. hystrix*
   Growing on *Halidrys siliquosa* and *C. fibrosa*. Rhizoids usually abundant . . . . . *S. bipinnata*
8. Branching sparse, irregular . . . . . *S. tribuloides*
   Branching dense, regularly pinnate . . . . . *S. plumula*
9. Plants usually partly endophytic . . . . *S. caespitula* (4)
   Plants not partly endophytic 10
10. Branching sparse, irregular; pericysts (5) present . . . 11
    Branching pinnate; pericysts absent 12
11. Unilocular sporangia in crowded racemes . . . . *S. racemosa*
    Unilocular sporangia not in racemes . . . . . *S. radicans*
12. Rhizoids formed in plane of branching. Unilocular sporangia on ordinary secondary branches . . . . . *S. plumigera*
    Rhizoids arising in all planes. Unilocular sporangia usually borne on special stichidia arising from corticating rhizoids of axis *S. plumosa* (*Chaetopteris plumosa*)

(1) Occasionally encountered in *S. britannica* and *S. saxatilis* (Lund, 1950).

(2) The distinctness of this taxon from *S. saxatilis* is questionable (Lund, 1950): plurilocular sporangia might therefore occur on the former, but to date have not been described for it.

(3) Includes *S. fusca* (Huds.) Ag. For key to infraspecific taxa see p. 30.

(4) *S. olivacea* Pringsheim (growing on stones and shells, not penetrating substratum) is referred to this species by Lund (1950).

(5) Pericysts are cells without secondary transverse divisions, differing slightly in colour and general appearance from ordinary cells and serving as initials for the development of branches, propagules, rhizoids and sporangia. The term was devised by Sauvageau.

S. BRITANNICA Sauvageau.

S. olivacea auct. Traill (1889 *a*), pp. 77–78, pl. 2; Newton (1931), p. 189. Non *S. olivacea* Pringsh.

S. britannica Sauvageau (1901), pp. 27, 50–54, fig. 16; Waern (1945), pp. 402–404, pl. 2; Lund (1950), pp. 22–27, fig. 3.

This species may well be the original *C. olivacea* of Dillwyn (1809, p. 57), but the insufficiency of his description and the subsequent confusion surrounding that epithet have made it a *nomen dubium* which it is better to discard completely (*cf.* Lund, 1950). In older herbaria and floras, specimens of this taxon are generally included under *S. radicans* or, following Batters (1890), listed as a variety *olivacea* of that species. It is, however, much commoner than records indicate, being widely distributed round our shores from the Channel Islands to the Orkneys (and presumably also the Shetlands, since it is found in the Faeroes (Børgesen, 1908)), and on the east and west coasts of Great Britain and Ireland.

Its most usual habitat in the British Isles is on shady rocks and in the mouths of caves about high-water mark, generally accompanied by *Rhodochorton rothii* (Turt.) Näg. and sometimes intermixed with *S. radicans*, where it forms dense, olive-brown mats of indefinite extent 2–5 mm. high. The mat consists of a horizontal layer of tightly interlaced, flexuous stolons, bearing rhizoids and spreading outwards from small discs, with erect filaments arising from discs and stolons, usually at a wide angle, with sparse irregular branches and devoid of hairs. The width of filaments is somewhat variable, from 15 to 30 μ, with occasional characteristic oval swellings, the segments being about 1–1½ times as long as broad. Filaments are usually 2 to 3 cells wide, and secondary transverse divisions are rare or absent, at least in British specimens.

Reproduction is by unilocular sporangia, globose (40-50 μ in diameter), borne most frequently on the erect filaments, usually singly from a segment, with a 1- to 3-celled stalk, rarely sessile. They are most abundant in winter, but have been found from September to April. Propagules are not known to occur.

In St. Andrews *S. britannica* is abundant in typical habitats and bears unilocular sporangia from October to April (Blackler, 1956).

S. SAXATILIS Kuck. emend. Sauv.

S. furcigera Kütz. var. *saxatilis* Kuck. Newton (1931), p. 189 pro parte?

S. saxatilis Kuck. emend. Sauv. Sauvageau (1900), p. 217; (1901), pp. 53, 376; (1903), pp. 83, 94; Lund (1950), pp. 27–29, fig. 4.

Inclusion of this species as British rests on a record in the list of Holmes and Batters (1890) from Swanage (Dorset). I have not seen any specimens from this or any other British locality. Newton (1931, p. 189) describes it as being partly endophytic on Fucaceae

and bearing hairs (not characteristics of *S. saxatilis*) and bearing unilocular and plurilocular sporangia. This description refers at least in part to *S. furcigera* which, however, is not known to possess either type of sporangium in European waters (Lund, 1950). Since *S. furcigera* frequently grows epiphytically upon *S. saxatilis*, it is not impossible that the latter, a Baltic species, may also sometimes occur with it in British waters, and it should be looked for. The following brief description is drawn largely from that of Lund (1950).

S. saxatilis is very similar to *S. britannica* in appearance, with a less pronounced disc formation and little differentiation between prostrate and erect filaments. Hairs and propagules are not recorded: where present they appear to belong to epiphytic *S. furcigera*. Unilocular sporangia are spherical, 33–45 μ in diameter, stalked or rarely sessile, in clusters or terminally on a long branch. Plurilocular sporangia are cylindrical, 33–125 $\mu \times 16$–25 μ, with a 1- to 3-celled stalk. Heligoland plants (Kuckuck) formed extensive mats on rocks and stones, along with *S. furcigera*. The Danish plants were epiphytic on the stipe of *Laminaria hyperborea* (Gunn.) Fosl., and accompanied by *S. caespitula*.

S. FURCIGERA Kütz.

S. furcigera Kütz. var. *saxatilis* Kuck. Newton (1931), p. 189 pro parte?

S. furcigera Kütz. Sauvageau (1901), p. 368, fig. 35; Lund (1950), pp. 29–32, fig. 5.

Reliable British records of this species are rare. In addition to the record from Swanage mentioned under the preceding species, which may well refer to this species, it has been reported from Looe (Cornwall), on *Cystoseira ericoides*, at M.L.W.S.T. level (Parke, 1950), Lerwick (Shetland Isles), on *Laminaria hyperborea* stipes, at a depth of 6 fathoms (Børgesen, 1903), and Moville (Co. Donegal), on *Corallina virgata*, at M.L.W.N.T. level (Blackler, 1951*). Such a sporadic distribution suggests that it is more generally dispersed, but is usually overlooked or confused with more common species.

Plants may grow superficially on rocks and calcareous algae, or with rhizoids penetrating more or less deeply into the tissues of various host plants, forming tufts about 1 cm. high. The erect filaments are sparsely branched, 20–30 μ broad, with segments 1 to 2 times as long as broad, with few (1–3) longitudinal and no secondary transverse divisions. Hairs are frequent.

Reproduction by unilocular and plurilocular sporangia has not

yet been reliably recorded in European waters, though known from warmer regions (Lund, 1950). Propagules, which are characteristically narrow, bifurcate with cylindrical arms of equal or, less usually, unequal length, are recorded from Looe, Lerwick and Moville, in each case in July.

S. PENNATA (Huds.) Lyngb.

Conferva marina perbrevis, villosa et cirrosa Dillenius (1741), t. 4, fig. 21.
Conferva pennata Hudson (1762), p. 486.
Conferva cirrhosa Roth (1800), p. 214.
Sphacelaria pennata Lyngbye (1819), p. 105.
Sphacelaria cirrosa (Roth) Agardh (1824), p. 164; Sauvageau (1902), p. 399, figs. 44–46; (1903), p. 32, fig. 6.

While no specimens of *Conferva pennata* named or checked by Hudson are known to exist, and his brief description and somewhat dubious references leave some uncertainty as to the precise taxon intended, the name *C. pennata* has long been accepted as referring to this species. In any case Agardh, in making the combination *S. cirrosa*, quotes "*Conf. pennata* Dillw. t. 86–Huds." and "*Sphacel. pennata* Lyngb." in his synonymy. Since he acknowledged these as synonyms he should have used the older legitimate epithet himself, and by not doing so made the combination *S. cirrosa* illegitimate. Doubtless Agardh considered *cirrosa* the earlier because of its use by Dillenius, as did Harvey (1846), but this is contrary to the rules of botanical nomenclature.

This is the most common and widely distributed species of the genus: it is therefore particularly unfortunate that its variability, confusion with closely related species (e.g. *S. bipinnata* and *S. hystrix*), inadequate description and lack of type specimens should have produced so many errors in nomenclature and identification that many early records are vitiated and knowledge of its habits, reproduction and range of form in British waters is at present correspondingly limited. It appears to be common or abundant on all coasts of the British Isles, ranging from the infralittoral to high-water mark, but especially luxuriant in mid-tide pools as an epiphyte on various small algae. It is probably perennial wherever local conditions permit its survival during the summer months.

Plants are saxicolous or epiphytic, forming small, dense, olive-brown tufts, 0·5–2·5 cm. high. The rather stiff erect filaments are 40–160 μ wide, irregularly or more or less pinnately branched, with

a single layer of prostrate filaments, forming a small, compact, basal disc. Rhizoids are scarce, confined to the lower parts of the plant and most frequently absent. Articulations are 1–1½ times as long as broad, with generally 3–5 longitudinal divisions; secondary transverse divisions are usually absent and pericysts do not occur.

Reproduction is most frequently by propagules with 2–5 (normally 3) arms, of distinctive shape in the different varieties and forms. In Britain they are rare in winter and most abundant in July and August. Unilocular sporangia are uncommon, but generally abundant on plants which bear them, globular, 75–100 μ in diameter, borne axially or on the lower parts of the ramuli on a short unicellular stalk or more rarely sessile. Reliable British records are few and indefinite, but indicate that they may occur at any season, though rather more frequently in winter. Early references without later confirmation must be rejected as probably pertaining to *S. bipinnata*. This also holds for records of plurilocular sporangia, which are very rare indeed, though recorded by Sauvageau (1902) from Gijon. They occur with unilocular sporangia and resemble those of *S. bipinnata*, being shortly cylindrical, 70–80 $\mu \times 60$–65 μ, on a usually bicellular stalk (Sauvageau, *l.c.*). A single personally determined record from Bognor (Sussex) in July is discussed under f. *septentrionalis*.

Key to British Varieties and Forms of S. pennata.

1. Propagules terminating in a cap cell, arms usually straight, cylindrical; branching sparse, irregular, ramuli often long and flexuous . . . . . var. *fusca*
   Propagules usually terminating in a hair, arms often recurved, cylindrical or fusiform, constricted at base; branching irregular, often somewhat pinnate . . . . . var. *pennata* (2)
2. Branches short, stiff, at right angles to main filaments; plants sterile . . . . . f. *patentissima*
   Branches flexuose, not usually markedly divaricate from main filaments 3
3. Plants small (5 mm. or less), forming compact, rounded tufts on *Desmarestia aculeata* . . . . . f. *nana*
   Plants usually more than 5 mm. high 4
4. Propagules with long cylindrical arms, straight or slightly recurved; cells of axial filaments often as long as or longer than wide . . . . . f. *septentrionalis*
   Propagules with fusiform arms; cells of axial filaments often shorter than wide . . . . . f. *meridionalis*

The limits of this most variable species and its infraspecific taxa have long been imperfectly understood. Sauvageau (1902) indicated the frequent errors of identification into which the earlier phycologists

had been led, and from the *S. cirrosa* complex he re-established *S. bipinnata*, clearly distinguished *S. hystrix*, and restored *S. fusca* as a species. The reasons for again reducing *S. fusca* to varietal status will be dealt with under that variety. He rejected the varieties *pennata* Hauck and *irregularis* Hauck, the former being more or less regularly pinnate, the latter irregularly branched. Certainly the ramification of this species seems far too variable for such a distinction to be maintained. The varieties *patentissima* Grev. and *nana* J. Ag. are perhaps doubtfully distinct; they are included here as forms. It is clear that one of these forms, probably f. *septentrionalis*, must have included Hudson's type specimen and should therefore be referred to f. *pennata*, but in the absence of a holotype or lectotype the form epithets must needs be retained until a neotype has been selected.

Var. *pennata*.

S. cirrosa Ag. Sauvageau (1902), pp. 399–416; Newton (1931), pp. 189, 190, excl. var. *fusca* and var. *aegagropila*; Lund (1950), pp. 32–37).

This variety is generally distributed round the shores of Britain, growing on rock, or epiphytic on various algae at mid-tide level and lower down the shore. Propagules are most frequent in July and August. Unilocular sporangia are infrequent, but have been noted in June, July and September to February at St. Andrews (winter, Isle of Man, Knight and Parke, 1931). Plurilocular sporangia are rare (May to July and September at St. Andrews).

f. *septentrionalis* comb. nov.

S. cirrosa (Roth) Ag. f. *septentrionalis* Sauvageau (1902), fig. 44.

This form is commoner than f. *meridionalis* in northern waters. It was the sole or dominant form in material examined from various British localities (Shetland, Orkney, Barra, Bute, Fife, Sussex, Merionethshire, Co. Donegal); f. *meridionalis* may be more frequent on the south coast, however (*cf.* Sauvageau, 1902, p. 406). It approaches var. *fusca*, from which it is distinguished by the usually more closely set and shorter, often opposite, ramuli, and in particular by the propagules, which usually terminate in an apical hair and have arms which are constricted at the base, often recurved and sometimes slightly fusiform. It bears propagules in July and August, and unilocular sporangia in July (Co. Donegal, leg. Blackler* Barra, leg. McMillan* Sussex, leg. Norkett*). Plurilocular sporangia

have been found in July (Bognor, Sussex, leg. Norkett*) accompanying unilocular sporangia. This specimen bore no propagules, and no host or habitat details are available, but similar specimens collected with it on various small algae bore abundant propagules and were readily referable to this species and form.

At St. Andrews it is abundant in a few deep pools, on rock and epiphytic, particularly on *Corallina officinalis* and *Cladophora rupestris*, where it may occur side by side with var. *fusca* on the same host plant.

f. *meridionalis* comb. nov.

S. cirrosa (Roth) Ag. f. *meridionalis* Sauvageau (1902), fig. 45.

This form is probably common on the south coast of England. Sauvageau examined specimens from Bognor and the Isle of Wight, and I have seen plants from Orkney referable to this form. The branches are relatively stiff, the cells of the axial filaments only as long as or shorter than they are broad, and the propagules generally shorter than is the case with f. *septentrionalis* and much less variable, while their arms are markedly fusiform. It bears propagules in June (Orkney, Bay of Work, leg. Trail*).

f. *patentissima* comb. nov.

Sphacellaria (sic.) *cirrhosa* var. *patentissima* Greville (1828), Crypt. Fl. VI, pl. 317.

Sphacelaria cirrhosa var. *patentissima* Grev. Newton (1931), p. 190; Sauvageau (1903), p. 46.

This is a small plant (about 1 cm.), the sterile form somewhat resembling *S. plumula*, in pressed herbarium specimens, with subopposite ramuli issuing at right angles to the axial filaments in all planes. Cells of the axial filaments are $1\frac{1}{2}$–2 times as long as broad. It has been recorded from Dorset (Weymouth, leg. et det. Holmes, August 1882*), Sussex (Bognor) and Bute (leg. Greville*).

f. *nana* comb. nov.

S. cirrosa (Roth) Ag. f. *nana* J. Ag. (1848), I: 35.

This is typically a very small infralittoral form, with more or less pinnate fronds, and occurs as dense globose tufts on *Desmarestia aculeata*, widely distributed round the British Isles and probably found wherever the host plant occurs.

var. *fusca* (Hudson) comb. nov.

Conferva fusca Hudson (1762), p. 486; Dillwyn (1808), pl. 95.

Sphacelaria fusca (Huds.) Agardh (1828), II, p. 34; Harvey (1846), pl. 149; Sauvageau (1902), p. 393; Taylor (1937), p. 130.

Sphacelaria cirrhosa (Roth) Ag. var. *fusca* (Huds.) Crouan (1852), no. 35 *pro parte quoad syn. excl. spec. distrib.*; Batters (1902), p. 39; Newton (1931), p. 190; Knight and Parke (1931), pp. 66, 111.

Sphacelaria cirrhosa (Roth) Ag. f. *fusca* (Huds.) Holmes and Batters (1890), p. 81.

The above is a list of the more important references to this taxon. As Sauvageau (1902) has indicated, its identity with the briefly described *Conferva fusca* of Hudson (1762) is, in the absence of authentic specimens, at least open to some doubt. Dillwyn's (1808) description and figures are somewhat conflicting, and the earliest authentic description is that furnished and illustrated by Harvey (1846).

The specimens known to Harvey came from the south coast of England (Devon and Cornwall), and early herbarium specimens from these localities in the British Museum and the Royal Botanic Garden, Edinburgh, are indeed very distinctive. The colour is a rich dark brown, the branching is rather sparse and irregular, and the propagules are large, with straight, cylindrical arms and without an apical hair. Where a host is also represented it is usually, though by no means always, *Cladophora rupestris*. It was mainly with specimens like these, from both sides of the English Channel, that Sauvageau also was familiar when he re-affirmed the taxon's specific rank. It is, however, widespread on both east and west coasts of Britain, growing on rock or on the smaller algae of the mid-tide pools, and is variable in degree and type of branching and in colour. The unilocular sporangia (not seen by Sauvageau, but figured by Dillwyn (1808) and mentioned by Knight and Parke (1931)) are similar to those of typical *S. pennata* and are, as in var. *pennata*, of relatively rare occurrence. The shape of the propagules and the invariable lack of an apical hair seem alone to be constant features separating this taxon from acknowledged forms of *S. pennata*. In view of the known variability of the form of propagule in *S. pennata*, distinction of a species on this basis alone seems unjustifiable, and the taxon is accordingly reduced to a variety of *S. pennata* pending the discovery of further more reliable diagnostic characters. This reduction in taxonomic status has been supported by the discovery of apparently intermediate specimens in shallow sandy pools near high-water mark at St. Andrews, with very

variable propagules some of which had slightly reflexed arms, often with a basal constriction. The cap cell of the propagule is, however, invariably without a hair, though these are at least frequent on even the most extreme specimens of f. *septentrionalis*.

The British distribution of the taxon is not known at all accurately, but the scanty references available and a preliminary check of herbarium material suggest that var. *fusca* is generally distributed around the British Isles and is the more common inter-tidal variety at least on eastern Scottish shores and in the Isle of Man (Knight and Parke, 1931). Propagules have been recorded throughout the year (except in May), but appear to be more abundant in summer and autumn. Unilocular sporangia have been recorded from the Isle of Man in winter (Knight and Parke, 1931) and spring (Parke, 1935), and from St. Andrews as detailed below. Plurilocular sporangia have not been recorded.

At St. Andrews, var. *fusca* is locally abundant in many shallow mid-tide rock pools, particularly as an epiphyte on *Corallina officinalis* and *Cladophora rupestris*, but is generally if sparingly distributed on rock and various algae at all levels from mean low-water neap-tide downwards to low-water spring tide level. Propagules have been recorded from June to March, and unilocular sporangia from October to December (Blackler, 1956).

S. HYSTRIX Suhr in Reinke.

Sauvageau (1902), pp. 331–349, figs. 39–41; (1903), pp. 309–313.

This species has not previously been recorded in Britain, but was found to be abundant on a plant of *Cystoseira tamariscifolia* (Huds.) Papenf. growing in a rock pool at low-water mark, Wembury, Devon, September 1953. It formed globular, bushy tufts a few mm. high, penetrating the host tissues, but not deeply, with frequent rhizoids towards the base. Branches were abundant, often terminating abruptly in a hair, and with numerous fusiform propagules. No sporangia were seen, but may possibly have occurred earlier in the year.

According to Hamel (1938), the plants form tufts 1–10 mm. high, basally endophytic, on *Cystoseira* spp., later with a superficial compact mass of rhizoids from which arise the erect filaments of two kinds, the first short, 35–45 μ wide, with growth quickly terminated, the second longer and stronger, 60–100 μ wide, with more numerous longitudinal cell divisions and with a much more prolonged period of growth. Rhizoids are usually few, descending often in a

loose spiral round the principal filaments. Unilocular sporangia are rare, spherical with a unicellular stalk, and borne on the long filaments. Plurilocular sporangia are of two kinds, borne on the short filaments of the same or different plants on a 1- to 2-celled stalk, the antheridia being orange, 55–90 $\mu \times 45$–52 μ, and the oogonia olive-brown, with much larger compartments, 55–85 $\mu \times 45$–65 μ.

The species is probably on its extreme northern limit on the south coast of England, and further details of its life cycle in these waters would consequently be of considerable interest.

S. BIPINNATA (Kütz.) Sauvageau.

S. cirrhosa Ag. var. *aegagropila* Griff. Newton (1931), p. 190.
S. bipinnata (Kütz.) Sauvageau (1902), pp. 381–392, figs. 41 L, 42; (1903), pp. 313–314; Clint (1927), 23 pp., 27 figs.; Lund (1950), pp. 37–42, fig. 7.

This species was first clearly separated from *S. pennata* by Sauvageau and, as already pointed out, is included or confused with it in the older papers and herbaria. It is, however, a very distinctive and usually readily recognisable species, probably generally distributed round the British Isles, as it occurs from Orkney (Sinclair, 1949) to Devon (Parke, 1952) and on the east and west coasts, though reliable Irish records are rare. It cannot be assumed that all specimens growing on the normal hosts of *S. bipinnata* are indeed that species, since forms of *S. pennata* also may grow on *Halidrys* (St. Andrews, var. *fusca**, Barra, var. *pennata**).

The plants form bushy, dark brown tufts, 1–2 cm. high, on *Halidrys siliquosa* and *Cystoseira fibrosa*. They occur from mid-tide level downwards, and are generally abundant where they are found. They are often very localised even where the host plants are much more widespread, as remarked by Clint (1927) and noted at St. Andrews. The species appears to grow at a higher level on the shore in more northern latitudes (*cf.* Sauvageau, 1903), though more numerous and detailed habitat records would be desirable to check this point. The erect filaments are basally endophytic, somewhat stiff, at first more or less regularly bipinnate, the branching becoming very irregular with the development of later branches. Rhizoids are generally abundantly developed from the lower parts of the older filaments and branches, growing downwards and often forming a loose cortication of the axial filaments. Hairs are usually common, at least in mid-summer. Unilocular sporangia are

common during most of the year, though rare or absent in spring and early summer, as indeed is the plant itself. They are oval, later spherical, 85–120 μ in diameter, on a unicellular stalk. Plurilocular sporangia are frequent, on the same or separate plants from the unilocular sporangia, cylindrical, 70–120 $\mu \times 40$–60 μ, on a 1- to 2-celled stalk. Propagules are very rare, and appear to resemble those of *S. pennata* f. *septentrionalis* (Clint, 1927, fig. 9).

In St. Andrews the species occurs abundantly on *Halidrys siliquosa* growing in large, rather sheltered mid-tide pools. Unilocular sporangia have been recorded from June to February and plurilocular sporangia from July to February (Blackler, 1956). Propagules have not been observed.

S. TRIBULOIDES Menegh.

Sauvageau (1901), pp. 233–242, figs. 28, 29; (1903), pp. 53–55, fig. 47; Newton (1931), p. 189; Lund (1950), pp. 42–44, fig. 8.

This species appears to be very rare in the British Isles, but may easily have been overlooked or confused with species of similar habit, particularly when sterile. It has been recorded only from East Lothian (Dunbar, leg. Holmes, 1884 (Traill, 1890) and 1895*) and Northumberland (Hawick, leg. Batters), from June to October (Batters, 1890), in rock pools between tidemarks, often with *S. pennata*.

The plants form stiff, erect tufts, 1–2 cm. high, the slender (*ca.* 30 μ thick), erect filaments being sparsely and irregularly branched and rising from short creeping stolons. The articulations are $1\frac{1}{2}$–2 times as long as broad (Batters, 1890), with 1 to 3 longitudinal divisions, secondary transverse divisions being absent or very rare. There are no rhizoids.

Reproduction is largely (possibly in these islands entirely) by means of propagules of very characteristic shape and usually abundant when present. These are tribuliform, when mature almost as broad as long, with three very short horns. Unilocular sporangia are rare, and as yet unrecorded in Britain. They are spherical, on a unicellular stalk, scattered or unilateral (Sauvageau, 1903, fig. 47). Plurilocular sporangia are likewise rare, and are unrecorded in Britain. They occur with unilocular sporangia and are cylindrical, 60–80 $\mu \times 50$–55 μ, shortly stalked and often unilateral (Sauvageau, 1901, fig. 29 L).

S. PLUMULA Zanard.

Sauvageau (1901), pp. 94–111, figs. 18–20; Newton (1931), p. 191; Lund (1950), pp. 44–46, fig. 9.

This species has been recorded rarely in Britain in widely scattered localities, mainly on the south coast of England (Cornwall*, Devon, Dorset*, Sussex), though also in Guernsey and the Isle of Man. The only Scottish record is from Arran (leg. Batters, 1891), and in Ireland from Co. Donegal (Blackler, 1951) and Galway (Cotton, 1912). It is probably much more frequent, but being a small infralittoral species is rarely encountered.

The plant forms small, erect tufts about 1 cm. high, arising from a few creeping, somewhat thickened filaments, growing at low water or sublittorally on rocks, shells, amongst *Zostera* or on various algae. The erect filaments are pinnately branched, the articulations being 100–120 μ broad, rather broader than long, with 5 to 7 longitudinal divisions but without secondary transverse divisions. The branches are opposite, closely set, generally simple, and in one plane only. Rhizoids are few, growing downwards closely adpressed to the main axis but without forming a complete cortication as in the similar species *S. plumigera* and *S. plumosa*. Hairs are few or absent.

Propagation is mainly by propagules, which are tribuliform and very similar to those of *S. tribuloides* borne on the lower articulations of the primary branches. In Britain they have been found in June and August (Dorset, leg. Holmes*), August (Isle of Man, Parke, 1935) and September (Devon (Watcombe), leg. George*). Unilocular sporangia are rare, spherical (55–80 μ in diameter), usually on a unicellular stalk, and require further confirmation for British material. The record of pyriform unilocular sporangia given in the key and description of Newton appears most probably to refer to a very early stage of propagule development, as on certain specimens from Weymouth distributed by Holmes*. Plurilocular sporangia are unknown.

S. CAESPITULA Lyngb.

Sphacelaria olivacea Prings. emend. Sauvageau (1901), pp. 54–61.
S. caespitula Lyngb. Newton (1931), p. 190; Lund (1950), pp. 12–17, fig. 1.
Sphacelaria helgolandica (Kuck.) Waern (1945), pp. 399–400.

This is yet another species which has been rarely found, or at any rate recognised, in British waters and which urgently requires

further investigation. In Britain it has been reported only from Northumberland (Berwick, leg. Batters*), Carnarvon (Bangor (Batters, 1902)) and Fife (St. Andrews, Dunn*, 1939).

The plant consists of small tufts, 1–3 mm. high, growing in Britain on the stipes and holdfasts of *Laminaria hyperborea*, arising from a thick basal disc which is partially endophytic. The erect filaments are thin (20–30 μ wide), simple or with one or two short branches towards the apex, and the articulations have 1 to 3 longitudinal divisions and 2 to 3 secondary transverse divisions, with occasional pericysts (*cf.* Lund, 1950). Hairs do not occur.

Plurilocular sporangia are abundant where they occur. They are oval, 86–135 $\mu \times 62$–90 μ, borne on 3-celled pedicels, and are secund on the lower parts of erect filaments. They have been noted in January, February and September (Berwick, leg. Batters*), July and December (St. Andrews, Blackler, 1956). Unilocular sporangia and propagules are not known to occur in British material. Lund (1950) has united with this species *S. olivacea* Pringsh. emend. Sauv. The latter differs in growing superficially on stones, shells, etc., and in possessing unilocular as well as plurilocular sporangia. It has not, however, been recorded in British waters.

S. RADICANS (Dillw.) Ag.

Sauvageau (1901), p. 27, figs. 14A, B, E–J, 15; Newton (1931), p. 188; Lund (1950), pp. 17–22, fig. 2.

This is a common species generally distributed around the British Isles, growing on sand-covered rocks between tidemarks, often intermixed with other species (e.g. *S. britannica*, *S. racemosa* and *S. pennata*). It forms dark brown tufts, solitary or in loosely connected mats of indefinite extent, about 1 cm. high and by no means as densely and intricately compacted as those of *S. britannica*. The small basal discs are formed by the coalescence of prostrate filaments, some of which are produced to form simple or branching stolons which in turn give rise to new discs and erect filaments. These latter are somewhat stiff, 35–55 μ broad, with sparse, irregular branching, the branches being generally closely adpressed to the axial filament and of about the same diameter. Articulations are about as broad as long, with several longitudinal and one or more secondary transverse divisions. Yellow-brown pericysts occur in the upper articulations, giving rise to branches, rhizoids and sporangia. Hairs are rare, occurring in pairs or fours. The lower parts of the erect filaments bear numerous divaricate rhizoids.

Unilocular sporangia are ovoid or more usually globular, being borne sessile, or less often with a unicellular stalk, on the lower parts of erect filaments or more rarely on rhizoids. In Britain they appear to be produced principally in winter and early spring. A single plurilocular sporangium has been recorded by Kuckuck from Heligoland, while propagules are unknown.

At St. Andrews the species is widely dispersed from about M.H.W.N.T. level downwards on sand-covered rocks, often in company with *Rhodochorton floridulum*, and on the holdfasts of Fucaceae and *Laminaria* spp. Unilocular sporangia have been found rarely, in November to January and in March (Blackler, 1956).

S. RACEMOSA Grev.

Harvey (1851), pl. 349; Sauvageau (1901), pp. 137–143, fig. 23; Newton (1931), p. 189; Waern (1945), pp. 409–411, fig. 1; Lund (1950), pp. 46–48.

This is yet another species which is apparently very rare in British waters yet has been recorded from widely scattered localities —Northumberland (Berwick, Batters, 1890), Edinburgh (leg. Greville, 1819*), Fife (St. Andrews, Dunn, 1939*), Bute (Arran, Cumbrae, leg. Hennedy) and Pembrokeshire (Skokholm, Gillham, 1954). It appears to be largely confined to the northern parts of these shores, but in the sterile condition is very similar to *S. radicans* and is no doubt frequently overlooked. Holmes (1889) has cast some doubt on the authenticity of Hennedy's records, but Sauvageau (1903) has verified them from original specimens.

The plants form small, scattered tufts, resembling those of *S. radicans* but somewhat taller (more than 1 cm. high) and more tufted (Batters, 1890)), on sand-covered rocks in pools between tidemarks, sometimes gregarious but not forming true mats, as rhizoidal filaments, though present, are not numerous. The erect filaments are sparingly branched, the branches being irregular and often adpressed. Articulations are rather broader than long, with several longitudinal and one, sometimes two, secondary transverse divisions. Hairs and pericysts have not been recorded.

The sole reproductive organs known are unilocular sporangia, and when present these are very distinctive. They are oval or spherical, arranged racemosely in almost globular clusters on special short branches scattered over the main filaments and ramuli. In British waters they have been recorded in winter and spring.

At St. Andrews the species was found with abundant unilocular sporangia growing on sand-covered rocks about high-water mark over a restricted area in winter (Dunn, 1940), but appears to be somewhat spasmodic in its occurrence and has not been found in recent years.

S. PLUMIGERA Holm.

Holmes (1883), p. 141; Sauvageau (1901), pp. 111–116, fig. 22; Newton (1931), p. 191; Lund (1950), pp. 50–55, fig. 11.

This species is locally abundant, and apparently widely but disparately scattered round Great Britain. In Ireland it has been recorded only from Dublin (Batters, 1902). However, it has often been confused with the very similar *S. plumosa* (*Chaetopteris plumosa*). In Britain it grows intertidally on sand- and mud-covered rocks and in shallow pools, usually at about low-water spring-tide level.

Plants form tufts up to 10 cm. or more high arising from a discoid mass of coalescent filaments; the erect thalli are once or twice pinnately branched, branches of higher orders being irregularly or subdichotomously arranged. Articulations are longitudinally divided several times with one or more transverse divisions. Rhizoids arise in the plane of branching some distance below the apex, growing downwards closely adpressed to the axis, for which they eventually provide a complete cortication. Hairs may be absent, or if present may be terminal or sympodial, solitary or paired.

Unilocular sporangia are ovoid or spherical, 46–66 $\mu \times 45$–57 μ (according to Lund, *l.c.*) with 2- to 5-celled stalks, pinnately arranged on the pinnae, borne either directly or in racemes. Neither plurilocular sporangia nor propagules are known. In British waters fertile specimens have been recorded from December to May (Northumberland, Berwick, Batters, 1890).

In St. Andrews it is locally common in shallow sandy pools in the shade of the cliffs about high-water neap-tide level. Unilocular sporangia have been noted in November and from January to March (Blackler 1956).

S. PLUMOSA Lyngb.

Chaetopteris plumosa (Lyngb.) Kütz. Sauvageau (1901), pp. 144–149, fig. 24; Newton (1931), pp. 192, 193, fig. 121; Lund (1950), pp. 55–58.

S. plumosa Lyngb. Waern (1945), pp. 404, 405.

Reasons for abandoning the genus *Chaetopteris* are adduced by Waern (1945) and Lund (1950), and such a course appears strongly advisable. The species closely resembles *S. plumigera* in general appearance, and the two have been frequently confused. It is widely distributed around the British Isles but is by no means common, generally occurring in deep pools at low water or infralittorally, on rock, stones, shells and the basal parts of the larger algae.

The plant has a thick, perennial basal disc of coalescent filaments from which arise one to many main axes, at first regularly pinnate with opposite, simple ramuli, later with several axes of the second order borne irregularly or subdichotomously. These are themselves regularly pinnate, the lower parts of the primary axial filaments becoming bare by the dropping off of the lower pinnae. The frond is in general more ovate in form with longer pinnae than in *S. plumigera*. Downward-growing rhizoids, closely adpressed to the axis, are given off without order from some distance below the apex, eventually forming a compact cortical sheathing of the axis. Hairs may be very common (Lund, 1950).

Both unilocular and plurilocular sporangia occur, but on separate plants, on short stichidia which are borne in great numbers on the corticating rhizoids. Both unilocular and plurilocular sporangia are shortly stalked; the former is spherical, the latter shortly cylindrical. In Britain both types of sporangium are formed in winter and spring.

St. Andrews records of the occurrence of this alga are very few; it grows infralittorally and has been found as drift (Dunn, 1939) and on a *Buccinum* shell from about 3 fathoms. Unilocular sporangia have been observed in February, plurilocular sporangia in February and August.

DISCUSSION.

That eight of these thirteen species have been recorded in the not particularly rich algal flora of St. Andrews would seem to point to a much more general distribution of many of the species than is indicated by the paucity of British records. Several of the less well-known species, notably *Sphacelaria furcigera* and *S. racemosa*, have indeed been reported from such widely separated localities as to lead to the same conclusion. More widespread collection and investigation of material throughout the year, associated with careful recording of relevant ecological data, would undoubtedly

add to the known range of such species and provide information which is at present lacking concerning their times and methods of reproduction in British waters. Such work could, for example, help greatly in the elucidation of the range of form within *S. pennata*, and in determining whether *S. saxicola* is indeed a British species, and *S. hystrix* more than a very occasional immigrant, from across the English Channel. Even over stretches of coast which have been studied with comparative thoroughness there is much to be learned of this often neglected genus. There are still considerable areas of our coastline, for instance in north-west Scotland and in north-west and eastern England, for which algal records in general are exceedingly scanty. In many cases this is due to the barren nature of the shores, but members of this genus are adapted to such a wide range of habitats and tidal levels that it is likely to be represented to some extent on even the most inhospitable of coasts.

Finally, systematic and nomenclatural problems abound, and it would obviously be an advantage to discover diagnostic characters, if such exist, enabling a reliable key to be drawn up which was not based on features often difficult or impossible to ascertain, such as habitat or form of reproduction. Nevertheless, it is hoped that the above notes will provide adequate information for the identification of most British material, as well as an indication of some of the many problems and gaps in our knowledge which this interesting genus presents.

SUMMARY.

British species of the genus *Sphacelaria* are very imperfectly known and further work on them is urgently required. Thirteen species are described and a key is provided for their identification, with some details of their ecology, reproduction and geographical distribution in British waters, particularly for those which occur on the shores of St. Andrews, Fife, Scotland. The record of *S. saxatilis* requires further verification. *S. hystrix* is recorded from British waters for the first time. *S. fusca* is reduced to a variety of *S. pennata* (*S. cirrosa*), and the nomenclature and infraspecific divisions of the latter species are discussed and described in some detail.

ACKNOWLEDGMENTS.

Thanks are due to Mrs. Nelson of the Marine Biological Station, Port Erin, for Manx material of *S. pennata* var. *fusca*, to Mrs. Irvine of the British Museum for considerable assistance with the nomen-

clature and synonymy of *S. pennata* and for facilities to examine and refer to herbarium specimens, to Mr. D. M. Henderson for a like service in the herbarium of the Royal Botanic Garden, Edinburgh, and, in particular, to Dr. H. Blackler (University of St. Andrews) for supervision throughout the present work and for making available material from her own collections. The greater part of the work was performed during tenure of a scholarship awarded by the University of St. Andrews.

Bibliography.

Agardh, C. A. (1824). *Systema algarum.* Lund.
Agardh, C. A. (1828). *Species algarum*, **2.** Greifswald.
Agardh, J. G. (1848). *Species Genera et Ordines Algarum . . .*, **1.** Lund.
Amory, A. (1890). Alnmouth Marine Algae. *Hist. Berwicksh. Nat. Cl.*, 1887–89, **12,** 113.
Batters, E. A. L. (1890). A List of the Marine Algae of Berwick on Tweed. *Hist. Berwicksh. Nat. Cl.* 1887–89, **12,** 221.
Batters, E. A. L. (1902). A Catalogue of the British Marine Algae. *J. Bot. Lond.*, **40** (Suppt.), 107 pp.
Batters, E. A. L. (1907). Marine Algae of Lambay. *Irish Nat.*, **16,** 107.
Blackler, H. (1951). An Algal Survey of Lough Foyle, North Ireland. *Proc. Roy. Irish Acad.*, **54** (B), **6,** 97.
Blackler, H. (1956). The Phenology of Certain Algae from St. Andrews, Fife. *Trans. Bot. Soc. Edinb.*, **37,** 61.
Børgesen, F. (1903). The Marine Algae of the Shetlands. *J. Bot. Lond.*, **41,** 300.
Børgesen, F. (1908). *The Algae-vegetation of the Faeroese Coasts. Botany of the Faeroes*, **3.** London.
Chapman, V. J. (1937). A Revision of the Marine Algae of Norfolk. *J. Linn. Soc. (Bot.)*, **51,** 205.
Clint, H. B. (1927). The Life History and Cytology of *Sphacelaria bipinnata* Sauv. *Hartley Bot. Lab. Publ.*, No. 3, Liverpool.
Cotton, A. D. (1912). Clare Island Survey. 15. Marine Algae. *Proc. Roy. Irish Acad.*, **31,** 1.
Crouan, P. L. and H. M. (1852). *Algues marines du Finistère*, **3.** Brest.
Davey, A. J. (1953). The Seaweeds of Anglesey and Caernarvonshire. *Northw. Nat.* (N.S.), **1,** 272.
Dillenius, J. J. (1741). *Historia muscorum.* Oxford.
Dillwyn, L. W. (1802–9). *British Confervae.* London.
Dunn, M. D. (1939). The Marine Algae of St. Andrews Bay. *Trans. Bot. Soc. Edinb.*, **32,** 488.
Dunn, M. D. (1940). Seasonal Changes in Tidal Pools. *Trans. Bot. Soc. Edinb.*, **33,** 21.
Fritsch, F. E. (1945). *The Structure and Reproduction of the Algae*, **2.** Cambridge Univ. Press.
Gibb, D. C. (1938). The Marine Algal Communities of Castletown Bay, Isle of Man. *J. Ecol.*, **26,** 96.
Gibb, D. C. (1939). Some Marine Algal Communities of Great Cumbrae. *J. Ecol.*, **27,** 364.
Gillham, M. E. (1954). The Marine Algae of Skokholm and Grassholm Islands, Pembrokeshire. *Northw. Nat.* (N.S.), **2,** 216.
Greville, R. K. (1823–28). *Scottish Cryptogamic Flora.* 6 vols. Edinburgh.

Hamel, G. (1938). *Phéophycées de France.* IV. 248–261. Paris.
Harvey, W. H. (1846–51). *Phycologia Britannica.* Published in monthly parts. London.
Holmes, E. M. (1883). New British Marine Algae (Phaeophyceae). *Grevillea,* **11,** 140.
Holmes, E. M. (1889). Remarks on *Sphacelaria radicans* Harv. and *Sphacelaria olivacea* J. Ag. *Trans. Bot. Soc. Edinb.*, **17,** 79.
Holmes, E. M., and Batters, E. A. L. (1890). A Revised List of the British Marine Algae. *Ann. Bot. Lond.*, **5,** 62.
Hudson, W. (1762). *Flora anglica.* London.
Jack, J. (1890). Marine Algae of the Arbroath District. *J. Bot. Lond.*, **28,** 10.
Johnson, T., Hanna, H., Hensman, R., and Knowles, M. G. (1899). Irish Phaeophyceae (Report of the Fauna and Flora Committee). *Proc. Roy. Irish Acad.*, Ser. 3, **5,** 441.
Knight, M., and Parke, M. W. (1931). Manx Algae. *Liverpool Mar. Biol. Comm.*, Mem. 30.
Kylin, H. (1947). Die Phaeophyceen der schwedischen Westküste. *K. fysiogr. Sällsk. Lund Forh.*, N.F., **58,** 99 pp.
Lewis, E. A. (1936). An Investigation of the Seaweeds within a Marked Zone of the Shore at Aberystwyth during the Year 1933–34. *J. Mar. biol. Ass. U.K.*, **20,** 615.
Lund, S. (1950). The Marine Algae of Denmark, **2.** Phaeophyceae IV. *K. Biol. Skr.*, VI (2), 1.
Lyngbye, H. C. (1819). *Tentamen hydrophytologiae Danicae.* Copenhagen.
Newton, L. (1931). *A Handbook of the British Seaweeds.* Brit. Mus. Nat. Hist. London.
Oltmanns, F. (1922). *Morphologie und Biologie der Algen,* **2.** Jena.
Parke, M. W. (1935). Algological Records for the Manx Region. *Rep. Mar. biol. Sta. Pt. Erin,* **48,** 30.
Parke, M. (1950). Notes on the Plymouth Marine Flora. *J. Mar. biol. Ass. U.K.*, **29,** 257.
Parke, M. W. (1952). Flora of Devon, **2** (1). The Marine Algae.
Parke, M. W. (1953). A Preliminary Check-List of British Marine Algae. *J. Mar. biol. Ass. U.K.*, **32,** 497.
Rattray, J. (1886). The Distribution of the Marine Algae of the Firth of Forth. *Trans. Bot. Soc. Edinb.*, **16,** 420.
Rees, T. K. (1929). Marine Algae of the Coast of Wales. *J. Bot. Lond.*, **67,** 250.
Rees, T. K. (1931). Preliminary Observations on the Phaeophyceae of Lough Hyne (Ine). *J. Ecol.*, **19,** 439.
Rees, T. K. (1935). The Marine Algae of Lough Ine. *J. Ecol.*, **23,** 69.
Reinke, J. (1891). Beiträge zur vergleichenden Anatomie und Morphologie der Sphacelariaceen. *Bibl. Bot.*, 23.
Roth, A. W. (1797–1806). *Catalecta botanica.* 3 fasc. Leipzig.
Sauvageau, C. (1900–14). Remarques sur les Sphacelariacées. *J. Bot. Paris,* **14,** 1, 1900; **15,** 51, 1901; **16,** 167, 1902; **17,** 228, 1903; **18,** 332, 1904. Pp. 349–634 (separate publ.), 1914.
Sauvageau, C. (1903). Sur les variations du *Sphacelaria cirrosa* et sur les espèces de son groupe. *Mém. Soc. Sci. phys. nat. Bordeaux,* 6e ser., **3,** 309.
Sinclair, J. (1938). The Marine Algae of Barra. *Trans. Bot. Soc. Edinb.*, **32,** 432.
Sinclair, J. (1949). The Marine Algae of Stronsay. *Notes Roy. Bot. Gdn. Edinb.*, **20,** 170.
Taylor, W. R. (1937). *Marine Algae of the Northeastern Coast of North America.* University of Michigan Studies. Scientific Ser. 13. Ann Arbor.

THOMAS, E. M. (1953). A Preliminary List of Marine Algae of South-West Pembrokeshire. *Northw. Nat.* (N.S.), **1**, 568.

TRAILL, G. W. (1886). The Marine Algae of Joppa. *Trans. Bot. Soc. Edinb.*, **16**, 395.

TRAILL, G. W. (1889 *a*). The Fructification of *Sphacelaria radicans* and *Sphacelaria olivacea* J. Ag. *Trans. Bot. Soc. Edinb.*, **17**, 77.

TRAILL, G. W. (1889 *b*). The Marine Algae of Elie in the County of Fife. *Trans. Bot. Soc. Edinb.*, **17**, 156.

TRAILL, G. W. (1890). The Marine Algae of the Dunbar Coast. *Trans. Bot. Soc. Edinb.*, **18**, 274.

VALERA, M. DE (1939). Some New or Critical Algae from Galway Bay, Ireland. *K. fysiogr. Sällsk. Lund Förh.*, **9** (9), 11.

WAERN, M. (1945). Remarks on some Swedish Sphacelariaceae. *Svensk bot. Tidskr.*, **39** (4), 396.

WAERN, M. (1952). Rocky-shore Algae in the Öregrund Archipelago. *Acta phytogeogr. suec.*, **30**, 298 pp.

Further Additions to the Algal Flora of St. Andrews, Fife.

By Helen Blackler.
(Department of Botany, St. Andrews University.)

(Read by title, 15th December 1955.)

The following records are new for the St. Andrews area of the Fife coast, extending from the Eden estuary, two and a half miles north-west of St. Andrews, to Pitmilly, five miles south-east. All the algae have been found by the author (since 1951), or by Dr. M. D. Dunn (since 1939), or by Dr. D. E. G. Irvine. The initials M. D. D. refer to Dr. Dunn, Lecturer in Botany in the University of St. Andrews; D. E. G. I. stands for Dr. Irvine, now a member of staff of the University of Cambridge, and formerly a research student at St. Andrews. Uninitialed records are those of the author.

The following contractions have been used throughout:

M.H.W.S.T. —Mean high water of spring tides.
M.H.W.N.T.—Mean high water of neap tides.
M.L.W.S.T. —Mean low water of spring tides.
M.L.W.N.T.—Mean low water of neap tides.
E.L.W.S.T. —Equinoctial low water of spring tides.

DIVISION CHLOROPHYTA.

Class Chlorophyceae.

Order Ulotrichales.
Family Ulotrichaceae.

Ulothrix consociata Wille.

At M.H.W.N.T. as first colonist of a metre square quadrat of bared rock and on concrete path of the bathing-pool in May.

Ulothrix pseudoflacca Wille.

Occurs with *Sphacelaria britannica* and *Rhodochorton rothii* at the mouth of a cave at and above M.H.W.S.T. Determined by Dr. Mats Waern, Sweden. Found as first colonist of a metre square quadrat of bared rock in the mid-tide zone. Fertile January.

ENTEROMORPHA PROLIFERA (Müll.) J. Ag.

Occurs in pools and on rock from M.H.W.S.T. to M.H.W.N.T. Identified by Dr. C. Bliding, Sweden.

ENTEROMORPHA RALFSII Harv.

On the mud in the Harbour at E.H.W.S.T.–M.H.W.S.T. Fertile May.

ENTEROMORPHA RAMULOSA (Sm.) Hook.

In pools or on rocks in mid-tide zone in summer. Verified by Dr. C. Bliding, Sweden.

ULVA LACTUCA L. var. RIGIDA (C. Ag.) Le Jol.

Common from mid-tide region to M.L.W.S.T., in pools and on rocks, and epiphytic on *Laminaria hyperborea* stipes, on *Fucus*, on *Halidrys siliquosa* and *Polysiphonia nigrescens*. This variety can be readily distinguished from *Ulva lactuca* var. *latissima* by the darker green colour and glossy surface of the thallus, and by anatomical differences in size and arrangement of the cells.

Order CHAETOPHORALES.
Family CHAETOPHORACEAE.

ACROCHAETE REPENS Pringsh.

In the cortical cells of the stipes of *Laminaria digitata* and *Laminaria hyperborea*. Zoosporangia in December.

BOLBOCOLEON PILIFERUM Pringsh.

Often found in the thallus of small *Leathesia difformis* plants and in *Asperococcus fistulosus*, also in *Dictyosiphon foeniculaceus* in summer. Zoosporangia in June and September.

ECTOCHAETE LEPTOCHAETE (Huber) Wille.

Common in old plants of *Asperococcus bullosus* and *Ceramium rubrum*. July, September and October.

ECTOCHAETE WITTROCKII (Wille) Kylin.

Common in *Asperococcus fistulosus* and *Scytosiphon lomentaria* from May to September. Zoosporangia May and July.

ENTOCLADIA PERFORANS (Huber) Levring.

First found in March 1954 by D. E. G. I., ramifying amongst the superficial cells of *Ceramium rubrum*. Found by the writer in *Dictyosiphon foeniculaceus* in September 1954.

ENTOCLADIA VIRIDIS Rke.

Endophytic in *Monostroma fuscum*, *Asperococcus bullosus*, *Plocamium coccineum*, *Dumontia incrassata*, *Ceramium rubrum*, *Phycodrys rubens*. Often very abundant in old plants. Zoosporangia developing July.

PHAEOPHILA DENDROIDES (Crn.) Batt.

In *Scytosiphon lomentaria* September and November. Zoosporangia November.

PRINGSHEIMIELLA SCUTATA (Rke.) Marchew.

On *Polysiphonia lanosa* July 1952, and on *Polysiphonia urceolata* February 1954, by D. E. G. I.

ULVELLA LENS Crn.

Found on *Dumontia incrassata* May 1951, and on *Polysiphonia nigrescens* by D. E. G. I., March 1954.

Order CLADOPHORALES.
Family CLADOPHORACEAE.

CHAETOMORPHA CRASSA (Ag.) Kütz.

Found by D. E. G. I. forming loose strata on the mud of the Eden Estuary, October.

CLADOPHORA BLIDINGIANA Kylin.

Found on sandy reefs and rocks and in pools epiphytic on *Rhodomela confervoides* from September till March, from M.L.W.N.T. to M.L.W.S.T. The material was verified by Dr. C. Bliding, Sweden, and is the first record of this alga for Great Britain. Fertile September, October and November.

CLADOPHORA GLAUCESENS (Griff.) Harv.

Found by D. E. G. I. in a pool at M.H.W.N.T. and in pools in the mid-tide zone; identified by Dr. C. Bliding, Sweden.

CLADOPHORA RUPESTRIS (l) Kütz. f. NUDA (Harv.) Hamel.

Occurs in pools M.H.W.N.T.

CLADOPHORA TRAILLII (Batt.) Batt.

Grows on sand-covered rocks and in shallow pools from mid-tide to M.L.W.S.T. It appears in the spring in March and is abundant in April and May. Occurs at M.L.W.S.T. in September to December.

Zoosporangia March and April, zoids April and September. This lga was first found by Traill at Joppa near Edinburgh (Batters, 894), who noted that it was different from *Acrosphonia centralis* hich it resembles in some ways. It is also closely related to *crosiphonia albescens* Kjellm. Borgesen says "*Acrosiphonia raillii* belongs to this species" and quotes Batters' description. he material found at St. Andrews has the crenulated edged pore rough which the zoids are liberated, described by Borgesen. The t. Andrews material has been checked with Traill's material in atters' Herbarium with which it agrees.

HIZOCLONIUM TORTUOSUM (Dillw.) Kütz.

Forms long ropes of entangled filaments in pools, floating on the rface of the water. Also on rock faces in the summer from id-tide to M.L.W.S.T.

ROSPORA SPECIOSA (Carm.) Leblond ex Hamel.

Occurs in pools and on mud, and epiphytically on *Fucus serratus*, *ucus vesiculosus*, *Halidrys siliquosa* and stipes of *Laminaria yperborea* from M.H.W.S.T. to M.L.W.S.T.

rder SIPHONALES.

amily CODIACEAE.

ODIUM FRAGILE (Sur.) Hariot subsp. ATLANTICUM (Cotton) Silva.

Found in pools in one area in October 1955. Plants up to 150 mm. ng, growing in tufts, sterile. At M.H.W.N.T. towards M.H.W.S.T. aterial identified by Dr. P. Silva, Illinois, U.S.A.

For some years a green mossy growth of *Codium* has been observed n the vertical sides and the bottom of rock pools in the same area which *Codium fragile* subsp. *atlanticum* has now been found. reviously very small erect fronds, 25–50 mm. high, have been bserved from August to February, dichotomously branched with tricles on the average 420 μ long by 120 μ broad, rounded and on-mucronate (det. D. E. G. I.). This material looked like and greed in size and growth with the specimens of *Codium amphibium* und by McCalla at Roundstone, Co. Galway, Eire, and now in he Herbarium of Harvey in Trinity College, Dublin. The utricles the Irish material are, however, mucronate.

Typical plants of *Codium fragile* subsp. *atlanticum* have been und on this mossy growth, and the previously-observed plants milar to *Codium amphibium* are evidently juvenile forms of *odium fragile*. All stages of development can therefore be found

coming from the "moss", and well-developed plants are growing attached to the rock or epiphytic on *Corallina officinalis*.

The occurrence of *Codium* on the east coast of Scotland is of interest, as Batters (1902) records *Codium tomentosum* only from Peterhead, Aberdeenshire. The above record of *Codium fragile* subsp. *atlanticum* is a new one for the east coast of Scotland, though the taxon has been found on the Northumberland coast at Berwick-on-Tweed in October 1949 (Moss in litt. 1951) and on the Farne Islands in 1952 by Moss (Silva, 1955). It seems as though *Codium* is spreading on the east coast of Britain as is the case in other parts of the world—Denmark (Lund, 1940), Norway (Jorde, 1951).

Family Phyllosiphonaceae.

Ostreobium quekettii Born et Flah.

First found by D. E. G. I. in the periostracum of *Littorina littorea* at M.H.W.N.T. in July and in the periostracum of *Buccinum undatum*. Dredged in April by the writer.

DIVISION XANTHOPHYTA.

Class Xanthophyceae.

Order Heterococcales.
Family Halosphaeraceae.

Halosphaera viridis Schm.

Occurs in the plankton in St. Andrews Bay in the spring. Some years it is present in great quantity, so that the plankton when brought into the laboratory is like green-pea soup. This species is considered by Gran (1902) as an indicator species of the movement of warm Atlantic water. It was very abundant in March 1949 and February 1951.

Gametes were liberated from the material obtained in March 1949.

DIVISION CHRYSOPHYTA.

Class Chrysophyceae.

Order Chrysocapsales.
Family Chrysocapsaceae.

Phaeocystis pouchetii (Hariot) Lagerh.

Occasionally found in the plankton with *Halosphaera viridis* in March.

DIVISION PHAEOPHYTA.

Class Phaeophyceae.

Order Ectocarpales.
Family Ectocarpaceae.

ECTOCARPUS DRAPARNALDIOIDES (Crn.) Kjellm.

Growing on old plants of *Laminaria saccharina* in August, plurilocular sporangia present. On *L. digitata* May, with plurilocular sporangia.

ENDODICYTON INFESTANS Gran.

In *Obelia geniculata* with *Audouinella membranacea*. Also in *Dynamena sertularia* with *Epicladia flustrae* and *Audouinella membranacea*, and on *Membranifera membranacea* on fronds of *Laminaria hyperborea*, with plurilocular sporangia in October.

STIFFORDIA SANDRIANA (Zanard.) Hamel.

Occasional with plurilocular sporangia in September. M.L.W.S.T. infralittoral zone.

STIFFORDIA SECUNDA (Kütz.) Batt.

Found in pools in mid-tide zone on *Asperococcus fistulosus*. present in summer, plurilocular sporangia May and September, tetheridia August and September. In sandy pools at M.L.W.S.T. epiphytic on stipes of *Laminaria hyperborea* and *Rhodymenia palmata*.

HECATONEMA MACULANS (Coll.) Sauv.

Forming brown discs on *Rhodymenia palmata* with plurilocular sporangia in April. Also found on shell of *Buccinum undatum* taken in a lobster creel.

LAMINARIOCOLAX TOMENTOSOIDES (Farl.) Kylin.

Found in May and June on the stipes of *Laminaria digitata* at M.L.W.S.T. with *Ectocarpus fasciculatus* and *Litosiphon pusillus*. Plurilocular sporangia in May and June.

PHAEOSTROMA PUSTULOSUM Kuck.

On *Scytosiphon lomentaria* and on stipe of *Laminaria hyperborea* and on *Porphyra umbilicalis* f. *umbilicalis* in mid-tide zone to M.L.W.S.T. Plurilocular sporangia in May.

Streblonema fasciculatum Thur. var. fasciculatum.

Endophytic in *Eudesme virescens* in July 1952 in mid-tidal zone with plurilocular sporangia.

Waerniella lucifuga (Kuck.) Kylin.

Occurs on the roof and walls of a cave above M.H.W.S.T. and also on rock outside the mouth of another cave at M.H.W.S.T. It forms a brown felt-like growth above *Sphacelaria britannica* and *Rhodochorton rothii* in the first cave where it was found by Dr. Mats Waern, Sweden, in July 1952. Previously this alga has only been recorded from three caves in Britain by Batters (1906) from Sidmouth, 1901, Torquay, 1902, and Berwick-on-Tweed, 1904. Unilocular sporangia observed in March on material from both caves.

Family Lithodermataceae.

Petroderma maculiforme (Wollny) Kuck.

Found by D. E. G. I. as small dark spots on *Lithothamnion lenormandii* in a pool at M.H.W.N.T. Unilocular sporangia November.

Family Myrionemataceae.

Ascocyclus magni Sauv.

Occurs on the leaves of *Zostera* as small brown patches which become confluent with age and almost cover the surface of the old *Zostera* leaves. Plurilocular sporangia February, March, May, June and August. In pools just below M.H.W.N.T. Verified by Dr. Mats Waern.

Symphyocarpus strangulans K. Rosenv.

On old filaments of *Chaetomorpha litorea* in pools in the mid-tide zone. Forms a crust on the *Chaetomorpha*. Plurilocular sporangia September.

Family Elachistaceae.

Elachista scutellata (Sm.) Duby.

Grows on *Himanthalia elongata* in the summer and autumn at M.L.W.S.T. about two miles south of St. Andrews. This alga was found by M. D. D. on *Himanthalia* at Pitmilly after the publication of her list (1939). Unilocular sporangia August and September.

Order Dictyosiphonales.
Family Striariaceae.

Stictyosiphon griffithsianus (Le Jol.) Holm. et Batt.

Growing on *Laminaria hyperborea* and *Rhodymenia palmata* at M.L.W.S.T.

Family Punctariaceae.

Litosiphon filiformis (Rke.) Batt. var. filiformis

Minute tufts 5 mm. long on *Laminaria saccharina* in May with plurilocular sporangia at M.L.W.S.T.

Litosiphon pusillus (Carm.) Harv.

On *Laminaria digitata* with *Spongonema tomentosus* and on *Dumontia incrassata* in May and June at M.L.W.S.T. Unilocular sporangia May, plurilocular sporangia May and June.

Asperococcus bullosus Lamour.

Grows in pools with *Asperococcus fistulosus* but is not common, from M.H.W.N.T. to M.L.W.N.T. from May to October. Found by M. D. D. after publication of her list (1939). Only unilocular sporangia have been observed in May, June, July, September and October.

Family Dictyosiphonaceae.

Dictyosiphon chordaria Aresch.

Occurs in pools and on tips of *Halidrys siliquosa* fronds in the middle zone from May till November. Unilocular sporangia, May and November.

Dictyosiphon foeniculaceus (Huds.) Grev. f. foeniculaceus.

Grows in pools and on muddy reefs from M.H.W.N.T. to M.L.W.N.T. Epiphytic on *Chordaria flagelliformis* and *Fucus* spp. and *Halidrys siliquosa*. Most abundant in the summer but may persist in sheltered pools at M.H.W.N.T. through the winter. Found by M. D. D. after publication of her list (1939). Unilocular sporangia January, February, April, July, August, September, October and December.

Order Scytosiphonales.
Family Scytosiphonaceae.

Petalonia filiformis Batt.

Grows on rock faces at M.H.W.N.T. to M.H.W.S.T. from the end of October to May. This alga was first found by Batters at Berwick-on-Tweed and described in 1888. It is recorded only from Essex, the Isle of Wight and Berwick (Batters, 1902). Plurilocular sporangia occur from November to May.

Order Sphacelariales.
Family Sphacelariaceae.

Sphacelaria pennata (Huds.) Lyngbye f. septentrionalis (Sauv.) Irvine.

This form grows with *Sphacelaria pennata* var. *fusca*, often on the same host plant (*Cladophora rupestris* or *Corallina officinalis*), in deep pools in the mid-tide zone or on rock. Propagules have been observed in August. Det. D. E. G. I.

Family Cladostephaceae.

Cladostephus verticillatus (Lightf.) Ag.

This species was found by M. D. D. in 1939 after publication of her list and has not been seen since. Found by Buddo Rock and at Pitmilly.

Order Dictyotales.
Family Dictyotaceae.

Dictyota dichotoma (Huds.) Lamour. var. dichotoma.

Found by M. D. D. in a large pool at M.L.W.S.T. at Pitmilly, after publication of her list (1939).

Order Fucales.
Family Fucaceae.

Fucus vesiculosus L. f. evesiculosus Cotton.

Found on top of exposed rocks at M.H.W.N.T. just below *Fucus spiralis*. The plants agree in size and form with those found by Cotton (1912) on Clare Island, Co. Mayo, Eire.

DIVISION RHODOPHYTA.

Class Rhodophyceae.

Subclass Bangiophycidae.

Order Bangiales.

Family Erythropeltidaceae.

Erythrotrichia ciliaris (Carm.) Batt.

Present on *Obelia geniculata*, *Cladophora traillii*, *Laminaria hyperborea* and *Polysiphonia nigrescens* at M.L.W.S.T. Monospores June and September.

Erythrotrichia welwitschii (Rupr.) Batt.

Occurs on *Ralfsia verrucosa* on *Patella vulgaris* at M.L.W.S.T. as described by Batters (1902), who found it at Swanage and in Guernsey. Cotton (1912) recorded it from Clare Island. Monospores October.

Family Bangiaceae.

Conchocelis rosea Batt.

On *Spirobis laevis* on *Himanthalia elongata* and on *Balanus balanoides*, which are coloured pink with this alga. Found from M.L.W.N.T. to M.L.W.S.T.

Porphyra leucosticta Thur.

First found by M. D. D. after publication of her list (1939). Occurs from April to November in mid-tide zone to M.L.W.S.T., epiphytic on *Fucus serratus*, *Fucus vesiculosus*, *Laminaria digitata* and *L. hyperborea*. Monospores April, May, June, September and December. Carpospores June to November. Spermatia May to November.

Subclass Florideophycidae.

Order Nemalionales.

Family Acrochaetiaceae.

Acrochaetium sparsum (Harv.) Näg.

Found at M.L.W.S.T. on the stipes of *Laminaria digitata* and *L. hyperborea* in branched tufts, filaments penetrating the stipe tissue. Often grows with *Rhodochorton*, from which it is distinguished by

its larger size. Monospores April, May and September. Tetraspores July, September and November.

Order Gigartinales.
Family Phyllophoraceae.

Phyllophora traillii Holm. et Batt.

Growing on vertical rock faces at M.L.W.S.T. with *Phyllophora brodiaei* and on shaded rocks at M.H.W.M. in a cave.

Order Cryptonemiales.
Family Squamariaceae.

Rhododermis parasitica Batt.

Grows on the stipes of *Laminaria digitata* and *L. hyperborea*, where it forms smooth dark red patches. M.L.W.S.T.–E.L.W.S.T.

Family Corallinaceae.

Epilithon membranaceum (Esper) Heydr.

Epiphytic on *Chondrus crispus* and *Gigartina stellata* and other algae at M.L.W.S.T.

Lithophyllum corallinae (Crn.) Heydr.

On *Corallina officinalis* in mid-tide zone. Identified by Dr. S. Suneson, Sweden.

Lithothamnion polymorphum (L.) Aresch.

Found by M. D. D., referred to in list (1939) and in Dunn (1940). Occurs covering the bottom of pools from mid-tide zone to M.L.W.S.T.

Melobesia minutula Fosl.

Common on *Monostroma fuscum*, *Plocamium coccineum*, *Phyllophora rubens*, *Phycodrys rubens* and other algae, and common on cast-up material. This alga has not been recorded for Scotland previously. Identification verified by Dr. S. Suneson, Sweden.

Family Kallymeniaceae.

Callocolax neglectus Schm.

Found on cast-up *Callophyllis laciniata*. Tetraspores and cystocarps observed in November.

Order Ceramiales.
Family Ceramiaceae.

Callithamnion corymbosum (Sm.) Lyngb.

Found by D. E. G. I. on *Cystoclonium purpureum* in a lobster creel. Tetraspores July.

Callithamnion tetragonum (Wither.) Ag. f. brachiatum (Bonnem.) K. Rosenv.

Found growing at M.L.W.S.T. Tetraspores and cystocarps October.

Ceramium deslongchampsii Chauv.

Found by D. E. G. I. at M.H.W.N.T. growing in a pool on *Corallina officinalis*.

Ceramium fruticulosum (Kütz.) J. Ag.

Found by M. D. D. after publication of her list (1939). Grows on *Halidrys siliquosa* in mid-tide zone from winter to summer.

Ceramium pedicellatum (Duby) J. Ag.

Occurs in mid-tide pools and epiphytic on *Fucus* spp., *Polysiphonia nigrescens* and other algae. Tetraspores abundant throughout the year, especially in November and March. Cystocarps all the year. Spermatia August (D. E. G. I.).

Ptilothamnion pluma (Dillw.) Thur.

Found growing on the stipe of dredged *Laminaria hyperborea*. The alga formed a minute red fringe to the stipe and bore tetraspores and cystocarps October.

Spermothamnion strictum (Ag.) Ardiss.

Occurs from M.L.W.N.T.–M.L.W.S.T. Tetraspores August on *Fucus* stipe.

Family Delesseriaceae.

Cryptopleura ramosa (Huds.) Kylin f. ramosa.

Found by M. D. D. after publication of her list (1939). Cast shore.

Nitophyllum punctatum (Stackh.) Grev.

A small plant cast up in October with cystocarps.

Pantoneura angustissima (Turn.) Kylin.

Grows at M.L.W.S.T. and in infralittoral zone. Obtained by dredging, sometimes cast up. Tetraspores August, October, November, January and February. Cystocarps January.

Polysiphonia nigrescens (Sm.) Grev. f. affinis (Moore) J. Ag.

Occurs in pools and in mid-tide zone.

Polysiphonia spinulosa Grev. var. spinulosa.

On stipes of *Laminaria hyperborea*. Occasional. M.L.W.S.T. Cystocarps May.

Polysiphonia urceolata (Dillw.) Grev. f. formosa (Suhr.) J. Ag.

First found by M. D. D. after publication of her list (1939).

DIVISION CYANOPHYTA.

Class Cyanophyceae.

Family Chroococcaceae.

Aphanothece pallida (Kütz.) Raben.

Found by D. E. G. I. in a pool at M.H.W.N.T. growing in an area previously cleared of algae.

Merismopedia convoluta Breb. ex Kütz.

Found by D. E. G. I. in the Eden estuary.

Family Chamaesiphonaceae.

Dermocarpa incrustans (Reinsch) Batt.

Frequent on *Laurencia pinnatifida* especially in the winter at M.L.W.S.T.

Entophysalis crustacea (Ag.) Dr. et Daily.

Abundant in the periostracum of *Littorina littorea* in July. Found by D. E. G. I.

Family Oscillatoriaceae.

Symploca hydnoides Kütz. ex Gom. var. hydnoides.

Epiphytic on *Dynamena* sp. on *Polysiphonia nigrescens* April 1955.

In addition to the above algae, the fungus *Leptosphaeria chondri* (Rostr.) Rosenv. occurs in *Chondrus crispus*, at M.L.W.S.T. Perithecia were observed in the outer layers of the thallus.

Acknowledgments.

The writer wishes to thank Dr. C. Bliding of Sweden for identification and verification of certain species of *Enteromorpha* and *Cladophora*; Dr. S. Suneson, Sweden, for identification of *Lithophyllum corallinae* and confirmation of *Melobesia minutula*; and Dr. Mats Waern, Sweden, who found *Waerniella lucifuga*, determined *Clothrix pseudoflacca* and confirmed *Ascocyclus magni*.

Thanks are also due to Dr. P. Silva of the University of Illinois, U.S.A., for examining the *Codium* material; to Miss C. I. Dickinson, the Herbarium, Royal Botanic Gardens, Kew, for the loan of Mr. Cotton's specimens of *Fucus vesiculosus* var. *evesiculosus* from Clare Island. The writer also thanks Dr. G. M. Taylor, Keeper, Department of Botany, British Museum, for allowing consultation of specimens of *Cladophora traillii*, *Petalonia filiformis* and *Erythrotrichia welwitschii* from Batters' Herbarium; Professor Sir William Wright Smith, Regius Keeper, Royal Botanic Garden, Edinburgh, for allowing consultation of the Herbarium of G. W. Traill for specimens of *Codium amphibium* collected by Holmes and Tellam; and Dr. Webb, Botany Department, Trinity College, Dublin, for allowing me to see Harvey's Herbarium containing the type specimen of *Codium amphibium*.

Bibliography.

Batters, E. A. L. (1888). Description of Three New Marine Algae. *J. Linn. Soc. Lond. (Bot.)*, **24**, 451.

Batters, E. A. L. (1894). On *Acrosiphonia Traillii*, a New British Alga. *Trans. Bot. Soc. Edin.*, **20**, 213.

Batters, E. A. L. (1895). On Some New British Algae. *Ann. Bot. Lond.*, **9**, 316.

Batters, E. A. L. (1902). Catalogue of British Marine Algae. *J. Bot. Lond.*, **40** (Suppl.), 1.

Batters, E. A. L. (1906). New or Critical British Marine Algae. *J. Bot. Lond.*, **44**.

Børgesen, F. (1902). *Marine Algae. Botany of the Faeroes.* **2**, 339. Copenhagen.

Blackler, H. (1951). Recent Additions to the Algal Flora of St. Andrews, Fife. *Trans. Bot. Soc. Edin.*, **35**, 435.

Cotton, A. D. (1912). Clare Island Survey, Marine Algae. *Proc. Roy. Irish Acad.*, **31**, 1.

Dunn, M. D. (1939). The Marine Algae of St. Andrews Bay. *Trans. Bot. Soc. Edin.*, **32**, 488.

Dunn, M. D. (1940). Seasonal Changes in Tidal Pools. *Trans. Bot. Soc. Edin.*, **33**, 21.

Gran, H. H. (1902). Das Plankton des Norwegischen Nordmeeres. *Rep. Nor. Fish and Mar. Inv. Bergen*, No. 5, **2**, 12.

Harvey, W. H. (1844). Description of a New Species of *Codium* recently discovered on the West Coast of Ireland. *Ann. and Mag. Nat. Hist.*, **13,** 321.

Jorde, I. (1951). Observations on the Seaweed Vegetation near the Biological Station. *Universitetet I. Bergen Arbok. Naturv. rekke*, **5,** 4.

Lowe, D. N. (1935). Survey of the Marine Algae of the Coast of Fife. *Trans. Bot. Soc. Edin.*, **31,** 498.

Lund, S. (1940). On the Genus *Codium* Stackh. in Danish Waters. *Det. Kgl. Danske Videnskabernes Selskab Biologiske Meddelelser*, **15,** 3.

Parke, M. W. (1953). A Preliminary Check-List of British Marine Algae. *J. Mar. Biol. Ass. U.K.*, **32,** 497.

Silva, P. C. (1955). The Dichotomous Species of *Codium* in Britain. *J. Mar. Biol. Ass. U.K.*, **34,** 565.

Traill, G. W. (1885). *A Monograph of the Algae of the Firth of Forth.* Edinburgh.

Wilson, I. M. (1951). Notes on Some Marine Fungi. *Trans. Brit. Mycol. Soc.*, **34,** 540.

The Phenology of Certain Algae at St. Andrews, Fife.

By Helen Blackler.
(Department of Botany, St. Andrews University.)

(Read by title, 15th December 1955.)

Observations on the phenology of certain algae found on the shore at St. Andrews have been made during the past seven years and the following table has been compiled from these records. In most cases the time of reproduction of any one species has been found to show very little variation from year to year despite fluctuations in the climatic conditions. On analysis of the records of the one hundred and ninety-nine species, there are found to be fifty-seven which are fertile throughout the year, while most species reproduce during spring, summer or autumn; the number reproducing in winter is lower—one hundred and seven. In the Rhodophyta the records of asexual spores exceed those for sexual reproductive bodies, there being eighty-three species reproducing asexually and sixty-one sexually. In certain species where the asexual and sexual reproductive bodies are identical, the term zoid is used when it has not been possible to ascertain whether fusion occurred, in which case they would be proved gametes, or whether they remained independent as zoospores.

The algal fruiting records made by Dr. Dunn of St. Andrews University, and hitherto unpublished, corroborate the observations of the author. Any records obtained by Dr. Dunn which have not so far been found by the author are indicated by the capital letter D in brackets after the X. The capital letter I in brackets indicates that the record was obtained by Dr. D. E. G. Irvine. The capital letter B in brackets refers to Dr. C. Bliding of Sweden, who has identified some of the species of *Cladophora* and *Enteromorpha* by allowing the gametes of Scottish and Swedish material of the same species to fuse and then grow in culture. The capital letter S in brackets refers to Dr. S. Suneson of Sweden, who identified some of the calcareous algae and found them fertile. The nomenclature is according to the *Check List of British Marine Algae* (Parke, 1953), except for the genus *Sphacelaria* which is according to Irvine (1956).

1. *Reproductive Organs. Zoosporangia.*	Spring.			Summer.			Autumn.			Winter.		
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Chlorochytrium cohnii	..	..	X	X	..	..	X	X	..	..	..	..
C. inclusum	..	..	X	..	..	X	X	..	..	..	X	..
Ulothrix flacca	X	X	X	..	..	..	..	..	..	..	X	..
Monostroma fuscum	..	..	X	..	..	..	..	..	..	..	..	..
M. grevillei	X	X	..	..	..	..	..	..	..	..	..	X
Enteromorpha compressa	X	X	X	X	X	X	X	X	X	X	X	X
E. intestinalis	X	X	X	X	X	X	X	X	X	X	X	X
E. linza	..	..	X	..	X	..	..	..	..	..	..	..
E. prolifera	X	X	X	X	X	X	X	X	X	X	X	X
Ulva lactuca var. latissima	..	X	X	X	X	X	X	X	X	X	..	..
U. lactuca var. rigida	..	..	X	..	X	X	X	X	..	..	..	..
Acrochaete repens	..	..	..	..	..	..	..	..	..	X	..	..
Bolbocoleon piliferum	..	..	..	X	..	..	X	..	..	..	..	..
Ectochaete wittrockii	..	..	X	..	X	..	..	..	..	..	..	..
Entocladia viridis	..	..	..	..	X	..	..	..	..	..	..	..
Phaeophila dendroides	..	..	X	..	..	..	..	..	X	..	..	..
Gomontia polyrhiza	..	..	..	..	X (1)	..	..	..	..	..	..	..
Tellamia intricata	..	..	..	..	X (1)	..	..	..	..	..	..	..
Cladophora rupestris f. rupestris	X	X	X	X (1)	..	..	X	..	..	..	..	X
C. traillii	X	X	..	..	..	..	..	..	..	..	..	..
Rhizoclonium riparium	..	X	..	..	..	..	X	X	..	..	..	..
R. tortuosum		X	..	..	..	..	..	..	..	..	..	..
Urospora penicilliformis	..	..	X	..	..	..	..	..	..	X	..	..
U. speciosa	X	..	X	..	..	..	..	X	..	..	X	..

2. *Reproductive Organs. Gametangia.*	Spring.			Summer.			Autumn.			Winter.		
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Monostroma fuscum	..	..	..	..	..	X	..	..	..	X	..	..
M. grevillei	X	X	X	X	..	..	..	..	..	..	..	..
Enteromorpha compressa	X (I)	X (I)	X (I)	X (I)	X	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)
E. intestinalis	X (I)	X (I)	X (I)	X	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)
E. prolifera	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)	X (B)	X (I)	X (I)	X (I)
Ulva lactuca var. latissima	..	X	..	..	..	..	..	..	..	..	..	..
U. lactuca var. rigida	..	X	X	..	X	X	..	..	X	..	..	X
Cladophora blidingiana	..	..	..	..	..	..	..	..	X (B)	..	..	..
C. rupestris f. rupestris	..	..	X (I)	X (I)	..	..	X	..	X	..	..	..
Urospora penicilliformis	X	X	X	X	X	..	..	..	..	X	X	..
Halosphaera viridis	X	..	..	..	..	..	..	..	..	..	..	..
Vaucheria coronata	..	X ♀♂	..	..	..	..	..	..	..	..	..	..
V. dichotoma	..	X ♀	..	..	..	..	..	..	X ♀♂	..	X ♀♂	..
V. sphaerospora	..	..	..	..	..	..	..	X ♀♂ (I)	..	..	..	..
Giffordia granulosa	..	..	..	X ♂	..	..	..	..	..	..	..	..
G. hincksiae	..	..	..	..	..	..	X ♂	..	..	..	..	..
G. secunda	..	..	..	..	..	X ♂	X ♂	..	..	..	..	..
Tilopteris mertensii	..	..	..	X ♂	X ♂	..	..	..	..	..	..	..
Ascophyllum nodosum f. nodosum	X	X	X	X	..	..	..	..	..	..	..	X
Fucus serratus	X	X	X	X	X	X	X	X	X	X	X	X
F. spiralis	X	X	X	X	X	X	X	X	X	X	X	X
F. vesiculosus	X	X	X	X	X	X	X	X	X	X	X	X
Pelvetia canaliculata	..	..	X	X	X	X	X	X	X	X	X	..
Himanthalia elongata	X	..	..	X	X	X	X	X	X	X	X	X
Halidrys siliquosa	X	X	..	X	..	X	X	X	X	X	X	X

3. *Reproductive Organs. Zoids.*	Spring.			Summer.			Autumn.			Winter.		
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Ulothrix flacca	..	..	..	..	..	..	..	..	..	..	X	..
U. pseudoflacca	..	..	..	..	..	..	..	..	..	..	X	..
Monostroma fuscum	..	X	X	X	X	..	X	X	X	X	X	..
Enteromorpha linza	..	..	..	X	X	..	X	..	..	..	..	..
Chaetomorpha aerea	..	..	..	..	..	..	..	..	..	..	..	X
C. litorea	..	..	..	X	..	..	..	..	..	..	..	..
C. melagonium	X	..	..	..	..	..	..	..	..	X	X	X
Cladophora blidingiana	..	..	..	..	..	..	X	X	..	X	..	..
C. flexuosa	..	..	..	..	X	..	X	..	..	..	..	..
C. rupestris f. rupestris	..	..	..	..	X	..	X	X	X	..	X	X
C. traillii	..	X	..	..	..	..	X	..	..	..	..	..
4. *Reproductive Organs. Aplanospores.*												
Prasiola stipitata	X	X	..	..	..	..	X	X	X	X	X	X
5. *Reproductive Organs. Akinetospores.*												
Prasiola crispa	X	X	X	X	X	X	X	X	X	X	X	X
P. stipitata	X	X	X	X	X	X	X	X	X	X	X	X

6. *Reproductive Organs. Unilocular sporangia.*

	Spring.			Summer.			Autumn.			Winter.		
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Ectocarpus confervoides	..	..	X	..	..	..	..	..	..	..	..	..
E. fasciculatus	X	X	X	X	X	X	X	..	..	..	..	..
Giffordia granulosa	..	..	..	..	..	X	X	X	..	..	..	..
G. hincksiae	..	X	X	..	..	X	..	..	..	..	..	..
Herponema velutinum	X	..	..	..	..	X	X	X	X	X	X	X
Pylaiella littoralis	X	X	X	X	X	X	X	X	X	X	X	X
Spongonema tomentosum	..	..	X	..	..	X	..	..	..	..	..	..
Waerniella lucifuga	X	..	..	..	..	..	..	..	X (I)	..	..	..
Petroderma maculiforme	..	..	..	..	..	..	..	..	X	X	X	..
Ralfsia verrucosa	X	X (D)	X (D)	..	..	..	X	X	X	..	..	..
Myrionema strangulans	..	..	..	..	X (I)	X	..	..	..	..	..	..
Ulonema rhizophorum	..	..	X	X	..	X	..	..	..	..	..	..
Elachista flaccida	..	..	X	..	X	X (D)	..	X	X	X	..	..
E. fucicola f. fucicola	X	X	X	X	X	X	X	X	X	X	X	X
E. fucicola f. grevillei	..	..	..	X	X	X	X	X	X	X	..	..
E. scutulata	..	..	..	..	..	X	X	..	..	..	..	..
Leathesia difformis	X (I)	..	..	X	X	X	X	..	..	..	..	..
Chordaria flagelliformis	X (D)	..	X	X	X	X	X	X	X	..	X (D)	X (D)
Eudesme virescens	..	..	X	X	X	X	..	..	..	..	..	..
Isthmoplea sphaerophora	..	X	X	X	X	..	..	..	..	..	..	..
Stictyosiphon subarticulatus	..	..	X (D)	X (D)	X (D)	X (D)	X (D)	..	..	..	..	..
Myriotrichia filiformis	..	..	X	X	X	X	X	..	..	..	..	..
Desmotrichum undulatum	..	X	X	X	..	X	X	..	X	..	..	..
Litosiphon laminariae	..	..	..	X	..	..	..	..	..	..	..	..
L. pusillus	..	..	X	..	..	..	..	..	..	..	..	..
Punctaria plantaginea var. plantaginea	X	X	X	X	X	..	..	X	..	..	..	X
Asperococcus bullosus	..	..	X	X	X	..	X	X	..	..	..	..

6. *Reproductive Organs. Unilocular sporangia.*	Spring.			Summer.			Autumn.			Winter.		
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Asperococcus fistulosus f. fistulosus	X (D)	X (D)	X	X	X	X	X	X	X (D)	X (I)	..	X (D)
A. fistulosus f. vermicularis	..	..	..	X	X	X	..	..	..	..	..	..
Dictyosiphon chordaria	..	..	X	..	..	..	..	..	X	..	..	..
D. foeniculaceus f. foeniculaceus	..	X	..	X	X	X	X	X	X	X	X	X
D. foeniculaceus f. hippuroides	..	..	X	X	X	..	X	X	X (D)	..	..	..
Desmarestia viridis	..	..	..	X	..	..	..	..	..	..	..	..
Chorda filum	..	..	..	..	X	X	X	X	..	..	..	..
Laminaria digitata	X	X	..	X	..	X	X	X	X	..	..	..
L. hyperborea	X	..	..	..	..	..	..	X	..	X (D)	..	X
L. saccharina	X	X	..	..	..	X (D)	..	X	..	..	X	X
Alaria esculenta	X	X	..	..	..	..	..	..	..	..	X	..
Sphacelaria bipinnata	..	..	..	X	X	X	X	X	X	X	X	X
S. britannica	X	X	..	..	..	..	..	X	X	X	X	X
S. pennata var. pennata	..	..	..	X	X	..	X	X	X	X	X	X
S. pennata var. fusca	..	..	..	..	..	..	..	X	X	X	..	..
S. racemosa	..	..	..	..	..	..	..	..	..	..	..	X (D)
S. radicans	X	..	..	..	..	..	..	..	X (D)	X (D)	X (D)	..
S. plumosa	..	..	..	..	..	..	..	..	..	..	..	X
S. plumigera	X	..	..	..	..	..	..	..	X	..	X	X
Cladostephus spongiosus	X	X	..	..	..	..	X	X	X	X	X	X
7. *Reproductive Organs. Plurilocular sporangia.*												
Ectocarpus confervoides	X (D)	X	X	X	X	X	X	X	X (D)	..	..	..
E. draparnaldioides	..	..	X	..	..	X	..	..	..	..	..	..
E. fasciculatus	X	X	X	X	X	X	X	X	X	X	X	X
Endodictyon infestans	..	..	..	..	..	X	..	X	..	..	..	..

7. *Reproductive Organs. Plurilocular sporangia.*	Spring.			Summer.			Autumn.			Winter.		
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Giffordia granulosa	..	..	X (D)	X	X	X	X	X	X	X	..	..
G. hincksiae	..	X	X	X	X (D)	X	X	..	..	..	..	..
G. sandriana	..	..	..	..	..	..	X	..	..	..	..	..
G. secunda	..	..	X	..	..	..	X	..	..	..	..	..
Hecatonema maculans	..	X	..	..	..	..	..	..	..	..	..	..
Herponema velutinum	..	..	..	..	..	..	X	X	X	..	X	..
Laminariocolax tomentosoides	..	..	X	X	..	..	..	..	..	..	..	..
Mikrosyphar porphyrae	..	..	X	..	..	..	..	..	..	..	..	..
Phaeostroma pustulosum	..	..	X	..	..	..	..	..	..	..	..	..
Pylaiella littoralis	X	X	X	X	X	X	X	X	..	X	X	X
Spongonema tomentosum	..	..	X	X	X	X	X	X	..	..	..	..
Streblonema fasciculatum var. fasciculatum	..	..	..	..	X	..	..	..	..	..	..	..
S. parasiticum	..	X	X	X	..	..	..	X	..	..	..	..
Ralfsia verrucosa	..	..	..	..	..	..	..	..	..	..	X	..
Ascocyclus magni	X	..	X	X	..	X	..	..	..	..	..	X
Myrionema aeciodioides	X	..	..	..	..	..	..	..	..	..	..	..
M. strangulans	..	..	..	..	..	X	..	..	..	..	..	..
Symphyocarpus strangulans	..	..	..	..	..	..	X	..	..	..	..	..
Ulonema rhizophorum	..	..	X	X	..	..	..	..	..	..	..	..
Leathesia difformis	..	..	..	X	X	..	X	X	..	..	..	..
Isthmoplea sphaerophora	..	..	..	X	X	..	..	..	..	..	..	..
Myriotrichia filiformis	..	..	X	X	X	X	X	..	..	..	..	..
Desmotrichum undulatum	..	..	X	X	..	X	X	X	..	..	..	..
Litosiphon filiformis var. filiformis	..	..	X	X	..	..	..	..	..	..	..	..
L. laminariae	..	..	..	X	..	..	..	..	..	..	..	..
L. pusillus	..	..	..	X	..	..	..	..	..	..	..	..
Punctaria plantaginea var. plantaginea	X (D)	X	X	X	..	..	..	..	..	..	X (D)	X (D)
Petalonia fascia	X	X	X	X	X	..	X	X	X	X	X	X

7. *Reproductive Organs. Plurilocular sporangia.*	Spring.			Summer.			Autumn.			Winter.		
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Petalonia filiformis	X	X	X	..	..	..	..	..	X	X	X	X
Scytosiphon lomentaria var. lomentaria	X	X	X	X	X	X	X	X	X	X	..	X
Sphacelaria bipinnata	..	..	..	..	X	X	X	X	X	X	X	X
S. caespitula	..	..	..	..	X	..	..	..	..	X (D)	..	..
S. pennata var. pennata	..	..	..	..	..	..	X	..	X (I)	..	..	..
S. plumosa	..	..	..	..	..	X	..	..	..	..	..	X (D)
Cladostephus spongiosus	..	..	..	..	..	..	..	X	X (D)	X	X (D)	..
8. *Reproductive Organs. Propagules.*												
Sphacelaria pennata var. pennata	..	..	X	X	X	..	X	..	..	..	..	..
S. pennata f. septentrionalis	..	..	..	..	..	X	..	..	..	..	..	..
S. pennata var. fusca	X	..	..	X	X	X	X	X	X	X	X	X

	Spring.			Summer.			Autumn.			Winter.		
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
9. *Reproductive Organs. Monospores.*												
Tilopteris mertensii	..	..	X	X	X	..	..	..	..	..	..	..
Goniotrichum elegans	..	..	..	..	..	..	..	X	..	..	..	..
Erythrotrichia carnea	..	..	..	..	..	..	..	X	X	..	..	..
E. ciliaris	..	..	..	X	..	..	X	..	..	..	..	..
E. welwitschii	..	..	..	..	..	..	..	X	..	..	..	..
Bangia fuscopurpurea	X	X	X	..	..	X	X	X	X	X	X	X
Porphyra leucosticta	..	X	X	X	..	..	X	..	..	X	..	..
P. linearis	X	..	..	..	..	..	..	..	X	X	X	..
P. umbilicalis f. umbilicalis	X	..	..	..	..	X	X	..	..	..	..	..
P. umbilicalis f. laciniata	X	..	X	..	X	..	..	..	X	..	..	..
Acrochaetium daviesii	X	X	X	X	..	X	X	X	..	..	..	..
A. secundatum	..	X	X	X	X	X	X	X	..	..	X	..
A. sparsum	..	X	X	..	..	..	X	..	..	..	..	..
A. virgatulum f. virgatulum	..	..	X	X	..	X	X	..	..	..	..	..
A. virgatulum f. luxurians	..	..	..	..	..	X	..	..	..	..	X	X
Ahnfeltia plicata	X	..	..	..	..	..	..	..	..	X	..	X
Callithamnion hookeri	..	X	..	X (I)	..	..	..	..	..	..	..	..
10. *Reproductive Organs. Bispores.*												
Corallina officinalis	..	..	..	X	..	..	..	..	X	X	..	..
Epilithon membranaceum	..	..	..	..	..	..	..	X	..	..	..	..
Lithophyllum corallinae	..	..	..	..	..	..	..	..	..	X (S)	..	..
L. pustulatum f. laminariae	..	..	..	X	..	..	X	..	..	..	..	..
Melobesia minutula	..	..	..	..	..	..	X	..	..	..	..	..

11. *Reproductive Organs. Paraspores.*	Spring.			Summer.			Autumn.			Winter.		
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Callophyllis laciniata	X	..	..	..	..	..	..	..	..	..	X	..
Callithamnion hookeri	..	X	..	X	..	..	..	..	X	..	..	..
Plumaria elegans	X	X	X	X	X	X	X	X	X	X	X	X
12. *Reproductive Organs. Tetraspores.*												
Acrochaetium daviesii	..	..	X	..	..	..	..	..	..	..	..	..
A. secundatum	..	X	X	X	..	X	..	X	..	..	..	..
A. sparsum	..	..	..	..	X	..	X	..	X	..	..	..
A. virgatulum f. virgatulum	..	..	..	..	X	..	..	..	..	..	..	..
A. virgatulum f. luxurians	..	..	X	..	..	..	..	..	..	..	..	..
Audouinella membranacea	..	..	X	..	X	..	..	X	..	..	..	..
Rhodochorton floridulum	X	X	X	X	X	X	X	X	X	X	X	X
R. rothii	X	X	X	X	X	X	X	X	X	X	X	X
Petrocelis cruenta	..	..	..	..	..	..	..	X	X (D)	X (D)	X (D)	..
Furcellaria fastigiata	..	..	..	..	..	..	X	..	X	X (D)	X (D)	X (D)
Cystoclonium purpureum	..	X	X	X	X	X	X	X	..	..	..	..
Plocamium coccineum f. coccineum	..	X	X	X	X	X	X	X	X	X	X	X
P. coccineum f. uncinatum	..	..	..	..	..	..	X	..	..	..	..	..
Phyllophora brodiaei	..	..	X	..	..	..	..	X	X	..	X	..
P. rubens	X	..	..	..	..	..	..	X	X	..	X	X
Chondrus crispus	..	..	X	X	..	X	X	..	X	X	X	X
Dilsea carnosa	..	..	..	..	..	..	X	X	X	..	X	X
Dumontia incrassata	X	X	X	X	X	X	X	X	X	..	X	..
Polyides caprinus	..	..	..	..	..	..	..	..	X	X	X	X
Hildenbrandia prototypus	X	..	X	..	..	X	..	..	..	..	..	..
Corallina officinalis	..	X	X	X	X	..	X	..	X (D)	X	X	X

12. *Reproductive Organs. Tetraspores.*

	Spring.			Summer.			Autumn.			Winter.		
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Melobesia minutula	..	..	..	..	..	..	..	..	..	..	X	..
Callocolax neglectus	..	..	..	..	..	..	..	..	X	..	..	..
Callophyllis laciniata	X	..	..	..	..	..	..	X	X	..	X	..
Choreocolax polysiphoniae	..	..	..	X	X	..	..	..	..	..	..	..
Lomentaria articulata	X	X	X	X	X	X	X	X	X	X	X	X
L. clavellosa var. clavellosa	X	..	..	X	X	X	X (D)	X	..	..	..	..
Rhodymenia palmata	X	X	X	X	..	..	..	..	X	X	X	X
Antithamnion pluma var. pluma	..	..	..	..	..	X	..	X (D)	..	..	..	..
Callithamnion arbuscula	X (D)	X (D)	X (D)	X	X (D)	X (D)	X (D)	X	X	..	X	..
C. corymbosum	..	..	..	..	..	X (I)	..	..	..	..	..	..
C. hookeri	X	X	X	X	X	..	..	X	X	X	X	X
C. tetragonum f. tetragonum	..	..	..	..	..	..	..	X	..	..	..	..
C. tetragonum f. brachiatum	..	..	..	..	..	..	..	X	..	..	..	..
Ceramium acanthonotum	..	..	..	..	X	X	X	X	..	..	..	..
C. diaphanum	..	..	..	..	X (D)	..	..	..	..	..	..	..
C. flabelligerum	..	..	..	..	..	..	..	..	X (D)	X (D)	X (D)	..
C. pedicellatum	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)
C. rubrum	X	X	X	X	X	X	X	X	X	X	X	X
Griffithsia flosculosa	X	X	X	X	..	..	..	X	X	X (D)	X	X
Plumaria elegans	X (D)	X (D)	X (D)	X (D)	X	..	X	X	X (D)	X (D)	X (D)	X (D)
Ptilota plumosa	X	..	X	X	X	X	X	X	X	X	X	X
Ptilothamnion pluma	..	..	..	..	..	..	..	X	..	..	..	..
Spermothamnion repens	..	..	..	..	..	X	X	X	X	..	..	..
S. strictum	..	..	..	..	..	X	..	X	..	..	..	..
Delesseria sanguinea	X	..	..	..	..	..	..	..	..	..	X	X
Hypoglossum woodwardii	..	..	..	..	X	X	X (D)	X	..	..	..	..
Membranoptera alata	X	X	X	X	..	X	..	X	X	X	X	X

12. *Reproductive Organs. Tetraspores.*	Spring.			Summer.			Autumn.			Winter.		
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Pantoneura angustissima	..	..	..	..	..	X	..	X	X	..	X	X
Phycodrys rubens	X	X	X	..	..	..	..	X	X	X	X	X
Heterosiphonia plumosa f. plumosa	X	..	..	..	..	..	..	X	X	..	X	..
Bostrychia scorpioides	..	..	..	..	..	..	..	X	..	..	..	..
Brongniartella byssoides	..	..	..	..	X (D)	..	..	..	..	..	..	..
Laurencia hybrida	X	X	X	X	X	..	..	X	..	..	X	X
L. obtusa	..	..	X	X	X	..	..	..	..	..	..	..
L. pinnatifida	X	X	X	X	X	X	X	X	X	..	..	X
Odonthalia dentata	X	..	X	X	..	..	..	..	X	X	X	X (D)
Polysiphonia brodiaei	..	X (D)	X	X (D)	X	X (D)	X (D)	X	X	..	..	..
P. elongata	..	X	X	X (D)	X (D)	X	X	X (D)	..	..	..	..
P. elongella	..	X	X	..	..	..	..	..	..	..	..	..
P. fibrata	..	X (D)	X	X	..	X	..	..	..	..	..	..
P. fibrillosa	..	X	X	X	X	X	..	..	X	X	..	..
P. lanosa	..	..	..	X	X	X	..	..	X	X	..	..
P. nigra	X (D)	X (D)	X (D)	X	X	X	X (D)	..	..	..	..	..
P. nigrescens f. nigrescens	X	X	X	X	X	X	X	X	X	..	..	X
P. nigrescens f. affinis	..	X	X	X	X	..	X	..	..	..	..	..
P. urceolata f. urceolata	X	X	X	X	X	..	..	..	..	..	X (D)	X (D)
P. violacea	..	..	X	X	..	..	..	..	X (D)	..	..	..
Pterosiphonia parasitica	..	..	..	..	..	X	..	..	..	..	..	..
Rhodomela confervoides	X	X	X	X	..	..	X	X	X	X	X	X
R. lycopodioides	..	..	..	X	..	..	..	..	..	..	X	..

13. *Reproductive Organs. Carpospores.*	Spring.			Summer.			Autumn.			Winter.		
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Bangia fuscopurpurea	X	X	X	..	..	..	..	..	..	..	..	X
Porphyra leucosticta	..	..	..	X	X	X	X	X	X	..	..	..
P. linearis	X	X	..	..	..	..	..	..	..	..	X	X
P. umbilicalis f. umbilicalis	X	X	X	X	X	X	X	X	X	X	X	X
P. umbilicalis f. laciniata	X	X	X	X	X	X	X	X	X	X	X	X
14. *Reproductive Organs. Cystocarps.*												
Furcellaria fastigiata	X	..	..	..	..	..	..	..	X (D)	X (D)	X (D)	X (D)
Cystoclonium purpureum	..	..	..	X	X	X	X	X	..	..	..	..
Plocamium coccineum f. coccineum	..	..	..	X	X	X	X	X	X	..	..	..
P. coccineum f. uncinatum	..	..	..	..	..	..	X	..	..	..	..	..
Phyllophora membranifolia	..	..	..	..	..	..	..	X	..	..	X	..
P. rubens	..	..	..	..	..	..	X (D)	X	X	X (D)	X (D)	X (D)
Chondrus crispus	X	X	X	..	..	X	X	X	X	X (D)	X (D)	X (D)
Gigartina stellata	..	..	..	..	..	..	..	X	X	..	..	..
Dumontia incrassata	X	X	X	X	X	..	X	X	X	..	..	..
Polyides caprinus	..	..	..	..	..	..	..	X	X	X	X	..
Corallina officinalis	..	..	..	X	X	X	X	X	X	X	X	X (D)
Callocolax neglectus	..	..	..	..	..	..	..	..	X	..	..	..
Callophyllis laciniata	..	X (D)	..	..	..	..	..	X	X	X	X	..
Harveyella mirabilis	..	X	X	..	..	..	..	..	..	..	..	X
Bonnemaisonia asparagoides	..	..	..	..	..	..	X (D)	..	..	..	..	..
Lomentaria articulata	..	..	..	..	X (D)	X	X	..	..	..	..	..
L. clavellosa var. clavellosa	..	..	..	X	X	X	X (D)	..	..	..	..	..
Antithamnion plumula var. plumula	..	..	..	..	..	X	X	X	..	..	..	..
Callithamnion arbuscula	..	..	..	X	X (D)	X (D)	X (D)	X	X	..	..	..

14. *Reproductive Organs. Cystocarps.*

	Spring.			Summer.			Autumn.			Winter.		
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Callithamnion hookeri	X	..	X	X	X (D)	..	..	..	X	X	X	X
C. tetragonum f. brachiatum	..	..	..	..	..	..	..	X	..	..	..	..
Ceramium acanthonotum	..	..	..	..	X (D)	X	..	..	X	..	..	..
C. diaphanum	..	..	..	..	X	..	..	..	..	..	..	..
C. pedicellatum	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)	X (I)
C. rubrum	X (D)	X (D)	X	X	X	X	X	X	X	X	X	..
Ptilota plumosa	X	X	X	X	X	X	X (D)	X (D)	X	X	X	X
Ptilothamnion pluma	..	..	..	..	..	..	..	X	..	..	..	..
Spermothamnion repens	..	..	..	..	..	X	..	..	X (D)	..	..	..
S. strictum	..	..	..	..	..	X	..	..	..	..	..	..
Delesseria sanguinea	X	..	..	..	..	..	..	..	X	..	X	X (D)
Membranoptera alata	X	X (D)	X (D)	..	..	..	..	..	X	..	..	X
Nitophyllum punctatum	..	..	..	..	..	..	..	X	..	..	..	..
Pantoneura angustissima	..	..	..	..	..	..	..	..	..	..	X	X
Phycodrys rubens	X	X	X	..	..	..	..	X	X	X	X	X
Heterosiphonia plumosa f. plumosa	..	..	..	..	..	..	..	..	..	..	X (D)	..
Laurencia hybrida	..	..	..	X	X	..	..	..	..	..	X	..
L. obtusa	..	..	..	..	..	..	X	X	..	..	..	..
L. pinnatifida	..	..	..	..	X	X	X	X	..	..	..	..
Odonthalia dentata	X	..	..	..	..	..	..	..	X	X	X	X (D)
Polysiphonia brodiaei	X (D)	X (D)	X (D)	X (D)	X	X (D)	X (D)	X (D)	..	..	..	..
P. elongata	..	X	X	X (D)	X (D)	X (D)	X (D)	X	X (D)	..	..	..
P. elongella	..	..	X	..	..	..	..	..	.. ..	..	..	..
P. fibrata	..	..	..	..	..	..	..	X	X	..	..	..
P. fibrillosa	..	..	..	X	X	..	..	..	X	..	..	..
P. lanosa	..	..	X	X	X	X	X	X	X	X	..	..
P. nigra	..	..	..	X	..	..	..	..	..	..	..	..

14. *Reproductive Organs. Cystocarps.*	Spring.			Summer.			Autumn.			Winter.		
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Polysiphonia nigrescens f. nigrescens	X (D)	X	X	X	..	..	..	..	..	..	..	X (D)
P. spinulosa var. spinulosa	..	..	X	..	..	X	..	X	..	..	X	..
P. urceolata f. urceolata	X	X	X	X	X	X	X	..	..	..	..	X (D)
P. urceolata f. formosa	..	..	..	X	..	X	..	..	..	..	..	..
P. violacea	X (D)	..	..	..	X	X	..	..	..	..	..	X (D)
Rhodomela confervoides	X	X	X	X	X (D)	..	..	..	..	..	X	X
15. *Reproductive Organs. Spermatia.*												
Bangia fuscopurpurea	X	X	..	..	..	..	..	..	..	..	..	..
Porphyra leucosticta	..	..	X	X	X	X	X	X	X	..	..	..
P. linearis	X	..	..	..	..	..	..	..	X	..	X	X
P. umbilicalis f. umbilicalis	X	X	X	..	X	X	X	X	X	X	X	X
P. umbilicalis f. laciniata	X	X	X	X	X	X	X	X	X	X	X	X
Furcellaria fastigiata	X	..	X	..	..	..	..	X	..	..	..	..
Chondrus crispus	..	..	..	..	X	..	..	..	..	..	..	..
Polyides caprinus	..	..	..	..	X	X	X	..	..	..	..	..
Corallina officinalis	..	..	..	..	X	..	..	X	..	..	..	..
Callithamnion hookeri	X	X	X	..	X	..	..	X	X	..	..	..
Ceramium acanthonotum	..	X	X	X	..	..	..	..	..	..	..	..
C. pedicellatum	..	..	..	..	..	X (I)	..	..	..	..	..	..
C. rubrum	..	..	X	..	..	X	..	..	..	..	..	..
Ptilota plumosa	..	..	X	..	..	..	..	..	..	..	..	..
Spermothamnion repens	..	..	..	..	..	X	..	..	..	..	..	..
Heterosiphonia plumosa f. plumosa	..	..	..	..	..	..	..	..	..	..	..	X
Laurencia hybrida	X	X	..	..	..	..	..	..	..	..	..	..
L. obtusa	..	X	..	..	..	..	..	..	..	..	..	..

15. *Reproductive Organs. Spermatia.*

	Spring.			Summer.			Autumn.			Winter.		
	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.	Jan.	Feb.
Laurencia pinnatifida	X	..	X	..	..	..	..	..	..	..	..	X
Odonthalia dentata	..	..	..	..	..	..	..	..	..	..	..	X (D)
Polysiphonia brodiaei	X (D)	X (D)	X	X (D)	..	..	X	..	X	..	X (D)	X (D)
P. elongata	X (D)	X (D)	X	..	X (D)	X	X	X (D)	..	..	..	..
P. elongella	..	X	..	..	..	..	..	..	..	..	..	..
P. fibrata	..	..	X (D)	..	..	X	..	X	..	..	..	..
P. fibrillosa	..	..	X	X	X	X	X	X	X	X	..	..
P. lanosa	X	X	X	X	X	..	..	..	..	..	..	..
P. nigrescens f. nigrescens	X (D)	X (D)	X	X	..	..	..	..	..	..	X (D)	X (D)
P. spinulosa var. spinulosa	..	..	X	..	..	..	..	..	..	..	..	..
P. urceolata f. urceolata	X	X	X	X	X	X	..	..	..	..	..	X (D)
P. violacea	..	..	X	X (D)	..	..	..	..	X (D)	..	..	..
Pterosiphonia parasitica	..	..	X	..	..	..	..	..	..	..	..	..
Rhodomela confervoides	X	X	..	X	..	..	..	..	..	..	X	X
R. lycopodiodes	..	..	..	X	..	..	..	..	..	..	..	..

Discussion.

Fruiting records of the algae have been kept at Naples (Funk, 927), Banyuls on the Mediterranean coast of the south of France Feldmann, 1937), Aberystwyth (Lewis, 1936), and Port Erin in the sle of Man (Knight and Parke, 1931). When these records are udied in detail, variation in the time of fruiting period and in the ind of reproductive body occurring at the different places may be orrelated with varying environmental factors in these localities.

Light, and sea and air temperature are the most important actors. Light is important when considered in connection with ne time of low water of spring tides, when algae are uncovered and xposed to the sun, except in the Mediterranean region where there practically no tidal rise and fall. Thus at Naples and Banyuls ne sea temperature and the penetration of the light must be the nportant factors.

At Aberystwyth, Port Erin and St. Andrews the time of low water f springs is different, being during the middle of the day at the first lace and in the early morning and evening (0600 and 1800) on the Manx coast, while it is a little later on the coast of Fife (0900 and 100). At Aberystwyth the algae are exposed to full insolation at ow-water springs throughout the year, while at Port Erin from the nd of October to the end of February low water of springs occurs uring darkness. At St. Andrews algae at M.L.W.S.T. are exposed o the morning light throughout the year, and during the summer re uncovered in the evening before dark as well.

With regard to temperature, the average winter sea temperature t Naples is the same as the average summer sea temperature of the nglish Channel (13°–14° C.), while in August at Naples the sea eaches the average maximum temperature of 28° C. On analysis f the fruiting records at Naples it is found that most of the algae re reproducing in the winter–spring period, the peak being in pring with a marked drop in the summer to an autumn minimum. he decrease in summer and autumn may be due to the high sea emperature.

In the Isle of Man, where the sea and air temperatures are higher nan in St. Andrews, there is a spring maximum with regard to the otal number of species reproducing with a gradual fall in summer nd autumn to a winter minimum, and in St. Andrews there is a inter minimum. If, however, the individual fruiting records are nalysed for the same species at the two places, considerable ariation may be found to exist, especially in the Rhodophyta.

There is a difference in the time and duration of reproduction and in the kind of reproductive bodies produced, and these differences may be correlated with the climatic and environmental features of the two regions.

Bibliography.

Feldman, J. (1937). Récherches sur la végétation marine de la Mediterranee. La Côte des Albères. *Revue Algologique*, **10**, 1.

Funk, G. (1927). Die Algenvegetation des Golfs von Neapel. *Pubblicazioni della Stazione Zoologica di Napoli*, **7**. Suppl. Tab. 5, 290.

Irvine, D. E. G. (1956). Notes on British Species of the Genus *Sphacelaria* Lyngb. *Trans. Bot. Soc. Edinb.*, **37**, 24.

Knight, M., and Parke, M. (1931). Manx Algae. *Liverpool Mar. Biol. Comm.*, Mem. 30.

Lewis, E. A. (1936). An Investigation of the Seaweeds of a marked Zone at Aberystwyth (1933–34). *J. Mar. Hist. Ass. U.K.*, **20**, 615.

Parke, M. W. (1953). *Rep. No. 48 of the Marine Biol. Station, Port Erin, Isle of Man*, p. 32.

Report of the Cryptogamic Section, 1955.

By D. M. Henderson.

The sixty-seventh annual autumn foray was held in Nairn and strict from 24th to 26th September. Darnaway estate forests were e collecting grounds for the first excursion. Before entering the oodland the comprehensive forestry museum of the estate, com-ising a fine collection of timber specimens and insect and fungal seases, was visited. From there the party was guided by r. Merchant, whose interest and co-operation contributed greatly the success of the day. Ancient mixed hardwoods at Sluie were xplored in the morning, whilst the afternoon was spent in old beech oods and the pine woods at Black Loch.

The morning and early afternoon of Sunday, 25th, were spent in e marshy pine woods on the south side of Loch Loy. This area as exceptionally dry and only occasionally could an agaric be und. The party then spent a most enjoyable two hours with the isses Baillie of Loch Loy estate, who very kindly showed the embers their garden and entertained them to tea.

The Section is indebted to the proprietors of the Darnaway forest nd of Loch Loy estate for permission to hold the meetings on their roperty. The excellence of the foray was in large measure due to r. J. B. Simpson, who made all the local arrangements. Mr. P. D. rton, who was welcomed as a guest, was responsible for most of the eterminations of agarics and has checked the final list. Seven embers attended the foray.

LIST OF FUNGI COLLECTED.

Unless otherwise stated, the nomenclature follows the Revised List of ritish Agarics and Boleti (*Trans. Brit. Mycol. Soc.*, 1948).

1. Darnaway. *a*, Sluie; *b*, Black Loch.
2. Loch Loy Woods.

MANITA CITRINA, 1*a*; MUSCARIA, 1*a*, 2.
RMILLARIA MELLEA, 1*a*; MUCIDA, 1*a*.
RICHOLOMA FULVUM, 1*a*, 2; MELALEUCUM, 2.
LITOCYBE GIGANTEA, 2; ODORA, 1*a*; FRAGRANS, 1*a*; AURANTIACA, 1*b*, 2.
ACCARIA LACCATA, 1*a*, 2; AMETHYSTINA, 1*b*.
YCENA PELIANTHINA, 1*a*; PTERIGENA, 1*a*; GALOPUS, 1*a*; HAEMATOPUS, 1*a*; AMICTA, 1*a*; ACICULA, 1*a*; AMMONIACA, 1*a*; VITILIS, 1*a*; GALERICULATA, 1*a*; SPEIREA, 1*a*.
OLLYBIA PLATYPHYLLA, 1*a*; MACULATA, 2.
ARASMIUS DRYOPHILUS, 1*a*; LIMOSUS Boud., 2.

Omphalia fibula, 1*a*.
Panus stipticus, 1*a*.
Lactarius torminosus, 2; deliciosus, 1*a*, 2; vietus, 2; blennius, 1*a*; quietus, 1*a*, 1*b*; glycyosmus, 2; rufus, 1*b*, 2; subdulcis, 1*a*; obscuratus Fr., 1*a*.
Russula delica, 1*a*; cyanoxantha, 1*a*; vesca, 1*b*, 2; fellea, 1*a*; xerampelina, 2; claroflava, 1*b*.
Pluteus cervinus, 1*a*, 1*b*; nanus (Fr.) Kuhn & Rom., 1*a*; lutescens, 1*a*; phlebophorus, 1*a*.
Entoloma jubatum, 2; sericeum, 2; sericatum Britz., 1*a*.
Leptonia poliopus Romagnesi, 2; sericella, 1*a*, 2; formosa, 2.
Nolanea staurospora, 2; juncea, 1*a*; dysthales Peck, 1*a*.
Pholiota mutabilis, 1*a*; togularis, 1*a*; blattaria, 1*a*; mycenoides sensu Jaap, 2.
Hebeloma crustulineforme, 1*a*; sacchariolens, 1*a*.
Naucoria alnetorum R. Maire, 1*a*, 2; centunculus, 1*a*; myosotis, 2; siparia, 1*a*; luteolofibrillosa Kuhner, 1*a*, 2; scolecina sensu Lge, 1*a*, 2.
Tubaria conspersa sensu Romagnesi, 1*a*.
Galera tenera, 1*a*; rubiginosa, 1*a*, 2; clavata, 2; ochracea, 1*a*.
Crepidotus phillipsii (Pleurotus roseolus Lge), 2.
Cortinarius porphyropus, 1*a*; lepidopus, 2; armillatus, 2; scandens, 2; safranopes Hry., 1*a*.
Inocybe lacera f. subsquarrosa Möller, 2.
Paxillus involutus, 2.
Stropharia squamosa, 1*a*.
Hypholoma hydrophilum, 1*b*.
Psilocybe elongata, 1*b*, 2; subericaea, 2.
Psalliota silvatica, 1*a*.
Coprinus micaceus, 1*a*; plicatilis, 2.
Gomphidius rutilus, 2.
Gyroporus castaneus, 1*a*, 2.
Boletus edulis, 1*b*, 2; luteus, 2; elegans, 1*a*, 2; flavidus, 2; piperatus, 2; variegatus, 2; chrysenteron, 1*b*; badius, 2; scaber, 2; versipellis, 2.
Polyporus forquinonii on *Ulex* branches, 2; caesius, 1*a*.
Uromyces laburni (DC.) on *Genista anglica*, 2.
Phragmidium rosae-pimpinellifoliae (Raben.) Diet., 2.
Puccinastrum galii, 1*b*; areolata, 1*a*; goodyerae, 1*b*.
Taphrina amentorum (Sadeb.) Rostrup on *Alnus incana*, 1*a*.

Committee for the Study of the Scottish Flora.

*B. L. Burtt (*Chairman*).
†B. W. Ribbons (*Honorary Secretary*).
Miss M. S. Campbell.
*Miss U. K. Duncan.
R. Mackechnie.
*Professor J. R. Matthews.
†J. G. Roger.
†Dr. G. Taylor.

This Committee will act under the joint ægis of the Botanical ociety of Edinburgh and the Botanical Society of the British Isles. t has been formed to further the study of the plants of Scotland by o-ordinating work on the Scottish flora on behalf of the sponsoring ocieties. Excursions and meetings will be arranged and announce- ients will appear in the publications of the two societies.

The Committee has appointed Mr. B. L. Burtt as its Chairman nd Mr. B. W. Ribbons (Department of Botany, The University, lasgow, W.2) as its Secretary.

First Annual Report to 31st December 1955.

The Committee was formed in April after discussions, during the revious twelve months, among numerous botanists in Scotland and ie two Societies. Two Committee meetings have been held in dinburgh, on 9th May and 17th September, and announcements f the Committee's existence and activities have appeared in the ionthly billets of the Edinburgh Society and in the *Proceedings* f the British Society. The Committee has arranged a programme f indoor and field meetings for 1956 and details are already ublished.

It was possible to arrange only a limited programme in 1955, onsisting of two meetings. An excursion attended by 15 people nd devoted to recording for the Maps Scheme took place to Elliot inks, Angus, on 2nd July. An Exhibition meeting held by kind ermission of the Regius Keeper at the Royal Botanic Garden, dinburgh, on 5th November attracted some 150 visitors. The hibits were chiefly illustrative of recent and current work on the

* Appointed by the Botanical Society of Edinburgh.
† Appointed by the Botanical Society of the British Isles.

Scottish flora, and Mr. J. Grant Roger gave a short popular illustrated lecture on some interesting Scottish plants. We are indebted to Miss Duncan and Mr. Burtt respectively for making local arrangements for these two meetings.

The Committee is particularly anxious to enlist the support of persons interested in the plants of Scotland but who so far are not members of either Society.

The Honorary Secretary wishes to express grateful thanks to the various officers of the two sponsoring Societies for much assistance.

CONTENTS.

PAGE

Proceedings of the Botanical Society of Edinburgh for 1954–55 . . . i

Presidential Address—Some Aspects of Root Study. By W. Burns . . 1

The Flowering Plants and Ferns of the Isle of May, Firth of Forth, Fife (v.–c. 85). By W. J. Eggeling 11

Notes on British Species of the Genus *Sphacelaria* Lyngb. By David E. G. Irvine 24

Further Additions to the Algal Flora of St. Andrews, Fife. By Helen Blackler 46

The Phenology of Certain Algae at St. Andrews, Fife. By Helen Blackler . 61

Report of the Cryptogamic Section, 1955. By D. M. Henderson . . . 79

Committee for the Study of the Scottish Flora 81